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PROCEEDINGS
OF THE
FORTY-FOURTH
INDIAN SCIENCE CONGRESS
CALCUTTA, 1957

PART IV

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PROCEEDINGS
OF THE
FORTY-FOURTH
INDIAN SCIENCE CONGRESS
CALCUTTA-1957

PART IV

LATE ABSTRACTS

Section I, Mathematics

1. A Radiating Star Embedded in an Expanding Universe.

P. C. VAIDYA *and* K. B. SHAH, Ahmedabad.

McVittie derived a solution of the field equations of general relativity which was a generalization of Schwarzschild's solution and which represented the field of a mass particle in the expanding universe. The space round the mass particle in this field is not empty but is occupied by a static distribution of matter with nonzero density and isotropic pressure, the distribution being spherically symmetric round the particles. Later Einstein and Straus working on the same problem derived a solution which was distinct from McVittie's solution in the sense that the space immediately surrounding the mass singularity was not occupied by matter and that this field in empty space passed over continuously to the expanding cosmological field over a definite boundary $r=P$.

If we try to study the Einstein-Straus problem in the case when the mass singularity at the origin of co-ordinates is a source (or a sink) of radiation, we immediately come across a fundamental difficulty over the cut-off boundary $r=P$. It is found that one of the O'Brien and Synge jump conditions cannot be satisfied at the boundary $r=P$. It is thus not possible to locate a definite cut-off radius $r=P(t)$ such that on one side of it we have a region traversed by pure flowing radiation and on the other side the expanding cosmic space.

A radiating star in an expanding universe presents a problem which is distinct from the Einstein-Straus problem of a cold static singularity. In this paper we have attempted to discuss the field of a radiating star embedded in an expanding universe on the lines suggested by the McVittie solution of the corresponding static problem.

2. Certain properties of the maximum function of a meromorphic function.

S. K. BOSE *and* R. P. SRIVASTAV.

Bose (Bull. Cal. Math. Soc., 1952) has defined S(r), the maximum function of a meromorphic function, f(z), in a restricted region as $\max_{|z|=r} |f(z)| \leqslant M_1(r)/m_2(r) = S(r)$, where $M_1(r) = \max_{|z|\leqslant r} |f_1(z)|$, $m_2(r) = \min_{|z|=r} |P(z)|$, P(z) being the canonical product formed with poles of f(z) and $f_1(z) = f(z)\,P(z)$.

In this paper, we have established certain properties of this function. They have been given in the form of three theorems and their applications.

3. Disturbances in different types of elastic media.

SAKTI KANTA CHAKRABORTY.

Disturbances generated by pressure on the surface of a spherical cavity inside (i) a dispersive medium, (ii) a medium having transverse isotropy about the radius vector have been considered.

4. On certain Hypergeometric Integrals and Triple Integrals due to Watson.

R. P. AGARWAL, Lucknow.

In this paper I have discussed certain hypergeometric integrals involving Lauricella's Hypergeometric functions. In the sequel, a generalised polynomial $F_B\ (a_1+N_1-1, \ldots, a_n+N_n-1;\ -N_1, \ldots, -N_n;\ y;\ -x_1, \ldots -x_n)$ has been studied. These polynomials are generalisations of the classical polynomials $U^{(s)}_{m_1, m_2, \ldots m_n}$ given by Appell and Kampe de Feriet.

Section II, Statistics

1. A two sample distribution free test for comparing variances.

B. V. SUKHATME, I.C.A.R., New Delhi.

The author (1955) had proposed a distribution free test for comparing variances based on sets of two observations, one from each of the two samples. The asymptotic efficiency of this test with respect to the most powerful variance ratio test against normal alternatives was found to be ·61. It has now been shown that the test can be improved further by considering sets of three observations. The asymptotic efficiency of the improved test with respect to variance ratio test against normal alternatives turns out to be ·69. The improved test is found to possess optimum priorities such as consistency and unbiasedness.

2. A statistical study of the variability of physical and mechanical properties of Tectona grandis (Teak) grown at different localities of India and Burma and the effects of the variability on the choice of the sampling plan.

K. R. Nair *and* H. K. Mukherji, Dehra Dun.

As timber is a biological product its composition and anatomical structure vary considerably from tree to tree and even between different parts of the same tree (butt to top and pith to periphery). Consequently its physical and mechanical strength properties vary to a great extent being mostly dependent on the above factors.

This paper deals with a detailed study of the different sources of variability and the relative magnitude of the variations due to each source of a selected number of physical and mechanical strength properties of twenty consignments of *Tectona grandis* (teak) in green condition received from different parts of India and Burma and tested in the Timber Mechanics Branch of the Forest Research Institute, Dehra Dun.

The main purpose of the study is to devise an efficient sampling plan i.e. to decide upon the number of specimens to be taken from each tree and the number of trees required to be tested to achieve a prescribed level of precision (in terms of standard error per cent of the species mean) at minimum cost possible.

3. Capital formation in corporate business sector in India.

K. A. Antony, Bombay.

An attempt is made in this note to estimate capital formation in corporate business sector in India during the First Five Year Plan period and the preceding four years. Estimates are made in respect of current assets and fixed assets (gross and net) and the annual rate of growth of these assets. These estimates are worked out on the basis of company finances statistics processed and published by the Taxation Enquiry Commission and Reserve Bank of India. Unpublished data in respect of 1954 and 1955 are obtained from the Reserve Bank of India. All companies are first classified according as they are public limited or private limited, and in respect of each sector estimates are made for manufacturing and non-manufacturing companies separately. On account of the homogeneous nature of the pattern of the distribution of assets of the companies falling in each category, it is found possible to estimate capital formation on the basis of known ratios between some items of the balance sheets of the companies covered by the studies of the Taxation Commission and Reserve Bank, and the companies not covered. Some adjustments which are found necessary are made and the estimates were checked by a number of ways. Total capital formation during the First Plan is estimated at Rs. 507 crores, of which Rs. 233 crores represent net fixed assets and the rest current assets. The capital formation in the whole sector is found to be roughly equal to the rate indicated in the Five Year Plan.

4. Models for multi-dimensional stationary stochastic processes.

T. V. Avadhani, Waltair.

Following Whittle models for two dimensional stationery stochastic processes were discussed by Heine by reducing the general second order stochastic partial differential equation

$$\left\{a\frac{\delta^2}{\delta x^2}+2h\frac{\delta^2}{\delta x\delta y}+b\frac{\delta^2}{\delta y^2}+2g\frac{\delta}{\delta x}+2f\frac{\delta}{\delta y}+c\right\}\zeta(x,y)=\varepsilon(x,y)\;.\;\;.\;\;.\;\;.\;\;.\qquad(1)$$

in two variables into standard elliptic, parabolic and hyperbolic forms where $\zeta(x, y)$ and $\varepsilon(x, y)$ are the variate and random impulses effecting it respectively both with mean zero. He found out the (Correlograms) correlation function and the Greens function in each case. The former characterises the given set of data and the latter is employed to distinguish between the time like and space like axes. In the case of the Parabolic and Hyperbolic models certain restrictive conditions were imposed for their admissibility.

But we come across in two dimensions examples of physical phenomena (Brownian motion of a uniform taught string, and the fluctuations of heat in an infinite rod) satisfying stochastic differential equations of a Hyperbolic and Parabolic type which are not covered by the above discussion. Further we have, in the theory of turbulence, a case of a three dimensional stochastic process.

The aim of this paper is therefore to extend the range of available two dimensional models to cover those left out by Heine and also to consider three and higher dimensional models of the elliptic and parabolic type. For all the models considered explicit expressions for the correlation and Green's functions are derived. With the help of the Greens function space like and time like axes are distinguished. In considering some of the above models we are naturally led to take $\varepsilon(x, y)$ on the right hand side of (1) more as an appropriate stationary process than merely as orthogonal random impulses. It is incidentally shown that it is not possible to have parabolic models beyond 2 dimensions and elliptic models beyond three dimensions with ε as purely random impulses.

The proofs of these are essentially based on Operational Methods involving two sided Laplace transforms.

Sampling error formulae for covariances and autocorrelations for K-dimensional stationary stochastic processes are obtained as direct generalisations of known results in one dimension.

The application of these results to actual data is in progress.

Section III, Physics

1. Treatment of elastic and inelastic scattering of high energy electrons on Be^9 using intermediate coupling nuclear wave functions.

MANOJ KUMAR PAL *and* SUPROKASH MUKHERJEE, Calcutta.

Contrary to the existent theoretical work on scattering of high energy electrons by nuclei which uses either a collective model or an independent particle model of the nucleus, the intermediate coupling shell-structure wave functions for Be^9 have been used for the calculation of differential scattering cross-section of high energy electrons on it. Elastic cross-section and inelastic cross-sections corresponding to the excitation of Be^9 to its 2·428 Mev and 6·8 Mev levels have been computed and compared with the experimental values obtained by McIntyre et al.

2. Detailed investigations into the effect of varying the parameters of Case and Pais interaction on n-p binding and scattering.

MANOJ KUMAR PAL *and* SUPROKASH MUKHERJEE, Calcutta.

The n-p binding problem and low and high energy scattering have been investigated with a two-body Hamiltonian containing central, tensor and spin-orbit parts. Serber type exchange dependence has been used for the central and tensor interactions and the effect of altering the exchange dependence and strength of the spin-orbit part has been studied. The present work differs from the existent ones in two respects : (i) the spin-dependent central term of the type $\vec{\sigma}_1 . \vec{\sigma}_1$ first suggested by Wigner has been omitted for simplicity, since tensor interaction in the Hamiltonian is alone able to produce the required difference between low energy singlet and triplet scattering; (ii) calculations have been made by extract numerical integration of the relevant nonhomogeneous coupled second order differential equations.

Although the three existent models—e.g., (i) Hard-core model of Jastrow, (ii) Singular tensor interaction model of Christian and Noyes, and (iii) Singular spin-orbit interaction model of Case and Pais—have all failed to produce the correct amount of polarisation in scattering as obtained in recent experiments, we have chosen the last named model and investigated it more thoroughly by exact numerical integration. The reason for this is the fact that in the treatment of heavy nuclei by the various coupling models of shell structure theory there has been an indispensable trend to use a single particle or two-particle type spin-orbit interaction. Since in such works the total manybody Hamiltonian is written as a sum of the two-body Hamiltonian for all pairs of nucleons, the Case and Pais interaction must still have some lingering interest in two body problem in order that two and many body problems may fit into the same consistent pattern.

3. Electric Quadrupole Moment of closed shell plus a single nucleon in the collective model.

PARESHNATH MUKHERJEE, Calcutta.

The magnitude of electric quadrupole moment of nuclei in the collective model with hydrodynamic approximation always comes out many times larger than observed values. Thus the calculated moment of $_8O^{17}$ is almost thirty times larger than the actual value, while that of $_{83}Bi^{209}$ is fourteen times greater. The present paper surveys critically the starting assumptions of the collective model and suggests that this large discrepancy is partly due to an under estimation of the nuclear inertial parameter, B, and partly to the assumption of a constant surface tension of the nucleus as given by Rosenfeld. The dependence of surface-tension on shell-structure as pointed out by Hill and Wheeler may be taken as a more closer picture. An attempt is being made to calculate the inertial parameter more accurately in the light of a recent publication by Aage Bohr. Some calculations have been already made, taking into account the rotation-vibration interaction of the nucleus, which was neglected by the previous authors.

4. The spectrum of the L x-rays from the electron capturing isotopes as an indicator of the order of forbiddenness of the decay.

R. K. GUPTA AND S. JHA, Bombay.

When the electron capture decay energy is large in comparison to the K electron binding energy, and the decay is of the allowod type, the majority of the electrons are captured from the K shell, some are captured from the $L_{I, II}$ shells, but none from the L_{III} shell. Rose has given formula for the ratio of capture from L_{III} and L_I shell in the case of electron capture decay with $\Delta J = \pm 2$, yes.

This theory has been tested by examining the L x-ray spectrum from $_{81}Tl^{204}$, which decays with a half life of about 4 years by emission in about 98% cases and by electron captures in about 2% cases: both the transitions are expected to be unique first-forbidden. The decay energy for the electron capture is 330 Kev. The x-ray spectrum was measured in an argon and methane filled proportional counter spectrometer. The observed intensities of the $L\alpha$, L_β and $L\gamma$ lines were compared with their intensities calculated on the basis that the decay was of the unique first-forbidden type, and that the capture ratio is as given by Rose. The intensity ratio of $L\alpha$, $L\beta$, and $L\gamma$ lines calculated with the calculated L_I, L_{II}, and L_{III} capture ratio of 12 : 1 : 3 was 7 : 6 : 1. The observed intensity ratio was about 6 : 6 : 1, which agrees with the predicted ratios.

5. Study with Scintillation Coincidence Spectrometer.

GIRISH CHANDRA *and* B. V. THOSAR, Bombay.

A conventional 'Slow-Fast' coincidence scintillation Spectrometer (resolving time $1{\cdot}5\times10^{-8}$ sec.) and also a triple coincidence Spectrometer (resolving time 4 μs) have been set up. Single Channel analysers have been used in all the Channels in order to select energies of gamma radiations. Gamma-Gamma double and triple coincidences have been studied in Cs^{134} and Sb^{125} in order to find out which gamma radiations form double and triple cascades. In case of Cs^{134}, the 604-kev gamma transition is found to be in cascade with 460 ± 20, 555 ± 15, 794 ± 15 and 1349 ± 30 kev gamma transitions, and the 794 kev gamma transition is found to be in cascade with 604 ± 10 and 555 ± 15 kev gamma transitions.

6. The Surface Tension of Liquid He^3

S. K. TRIKHA *and* M. P. SAWHNEY, Delhi.

Recently, Nanda and Trikha have proposed a model for liquid He^3. They describe liquid He^3 as a metal in which the ions and the electrons are replaced by particles of the same kind viz. He^3 atoms. A fraction of the total number of atoms corresponds to the free electrons in the metal and behaves as an ideal F.D. gas in a potential well of depth χ, while the rest of the atoms constitute a quasi-crystalline lattice. On the basis of this model the agreement between theoretical and experimental specific heat, entropy, vapour pressure and magnetic susceptibility is found to be fairly satisfactory.

The surface tension of liquid He^3, on the basis of a completely degenerate two-dimensional ideal F.D. gas, is found to be in complete disagreement with the recent experimental data. We have extended the model of liquid He^3 for the two-dimensional case also. It is found that, if the contribution to the free energy on account of the lattice vibration is ignored, the agreement between the predicted and experimental data for surface tension of liquid He^3 is fairly satisfactory.

7. Pressure distribution during one-dimensional flow through a rocket nozzle.

P. N. SHARMA *and* T. P. PANDYA, Lucknow.

Assuming complete chemical and internal equilibrium the time and space derivatives of pressure during one dimensional steady adiabatic flow through a rocket nozzle have been calculated. These derivatives are of importance because the velocity of take off of the rockets is connected with them. As all the "push" occurs inside the combustion chamber and at the throat, an expression for the pressure developed in the throat region has also been obtained.

8. Calculation of Transition Probabilities of BeO $^1\Sigma$—$^1\Sigma$ by Nicholls and Franz's.

S. M. DESAI *and* D. D. DESAI, Bombay.

Among the various methods available for computation of T. P. of diatomic molecules, that of Nicholls and Franz's has the special importance that it takes into account the anharmonity of the vibrations and are used to calculate the constants of the electric moment parameter.

An attempt has been made to try this method for the BeO $^1\Sigma$-$^1\Sigma$ system and computation of integrals of the type $\int \Psi v' \Psi v'' dr$, $\int \Psi_v' r \Psi_v'' dr$ and $\int \Psi_v' r^2 \Psi_v'' dr$ has been effected numerically and the results of the same are discussed in the paper.

9. The influence of magnetic field on the Longitudinal Stability of gravitating cylinder.

F. C. AULUCK *and* D. S. KOTHARI, Delhi.

The paper deals with the problem of the longitudinal stability of an infinitely long gravitating cylinder subject to the influence of magnetic field, the material is assumed to be incompressible, inviscid and infinitely conducting. The cases of current distribution inside the cylinder giving poloidal and toroidal fields are considered. The case of a uniform field (H_1) inside the cylinder and a uniform field (H_2) outside it is also described. The general conclusion is that in every case magnetic field increases the stability of the cylinder.

10. Studies on the long-lived Activity of Europium.

S. K. BHATTACHARYA *and* SHRI RAMAN, Bombay.

Long-lived activities of europium, Eu^{152} (13y) and Eu^{154} (16y), were studied by a coincidence scintillation spectrometer. The measured gamma-ray energies (Kev) and their intensities are 80±4 (0·52), 124±4 (1·85), 244±7 (1·00), 340±10 (2·16), 410±20 (0·15), 710±25 (0·34), 770±22 (1·27), 870±30 (0·57), 970±20 (1·93), 1090±21 (1·88), 1260±40 (5·0), 1410±25 (1·99). X-rays-gamma-rays, and gamma-gamma coincidence experiments were carried out by employing pulse-height selection; beta-gamma coincidences were recorded by using an anthracene crystal spectrometer. Decay schemes of the two isotopes are proposed on the basis of our experimental results. The first two excited states of Sm^{152} reached by the capture decay of Eu^{152} at 121 and 365 Kev are identified as rotational levels belonging to the ground state configuration; higher excited states in Sm^{152} ($N=90$) were also reached by capture decay of Eu^{152}. On the other hand the first two excited states of Gd^{152} ($N=88$) reached by β-decay of Eu^{152} at 340 and 750 Kev are probably vibrational in origin. The ground state spin of Eu^{152} is assigned as 4. The newly found gamma-ray of energy 80 Kev is identified as the one arising due to de-excitation of the first rotational level of Sm^{154}, a state which has also been observed in Coulomb excitation experiments. Decay schemes are discussed in the light of the unified nuclear model.

11. Parity and the Heavy Unstable Particles.

B. M. UDGAONKAR, Bombay.

It is proposed that the heavy unstable particles may be produced, not in a state of definite intrinsic parity, but in a state of mixed parity. For the hyperous, this would lead to certain anomalous features in the decay angular distributions. For the K-particles, this would provide an explanation of the $\theta - \tau$ degeneracy.

12. Point discharge current, the earth's electrical field and rain charges during disturbed weather at Poona.

M. V. SIVARAMAKRISHNAN, Poona.

An analysis of measurements of the current flowing to earth through an insulated point set up at the Meteorological Office, Poona at a height of 17·8 meters together with simultaneous measurements of potential gradient by a quick run photographic electrograph during twelve thunderstorms in 1955 show that point discharge currents of either sign can be represented as increasing with the squre of the field as found by Whipple and Scrase for Kew, Hutchinson for Durham, Chiploukar for Colaba (Bombay). An advancement of the field change ahead of the corresponding point discharge current is shown during a few thunderstorms at Poona like the one noticed by Hutchinson for Durham. Simpson's 'mirror image' effect is also shown by Poona records but the synchronisation of the change in the sign of the rain current is more with the field change rather than with the point discharge current which lags behind the field change.

Preliminary results with four-point discharger show that the total current is more than the current from a similar single point for the same field.

Section IV, Chemistry.

1. *Thermal Polymerization of D.C.O.—Effect of intramolecular reaction on the conjugated isomer of DCO.*

V. R. KESKAR *and* K. K. DOLE, Poona.

Dehydrated castor oil samples, obtained by using different catalysts, showed different rates of thermal polymerization. The difference in this rate of polymerization is attributed to the effect of :

(*a*) The catalyst used for the dehydration of castor oil.
(*b*) The extent of dehydration of the oil.
(*c*) The percentage of conjugated isomer formed in DCO. and,
(*d*) The side-reactions that occurred during the preparation of dehydrated castor oil.

Two types of reactions are found to occur during the thermal polymerization of DCO., which are governed by the factors mentioned above. In the first type, normal inter-molecular polymerization took place with the result that corresponding to the loss in unsaturation there was normal increase in the molecular weight. In the other type of reaction, there was a pronounced intra-molecular reaction and there was very little increase in molecular weight. It is observed that a substantial part of the catalyst remains in the oil and has a profound effect on the polymerization of DCO sample.

Both intra- and inter-molecular reactions occur during the polymerization of DCO samples. In some cases the former reaction is negligible, while in some other cases it is prominent. Two samples, representing the above mentioned cases, are polymerized and the effect of intramolecular reaction on the conjugated isomer of DCO is studied. When intramolecular reaction occurs there is a rapid decrease in the conjugated isomer of DCO, probably by the formation of ring structures in the molecule. In the beginning there is a rapid decrease in the absorption at 232mμ and afterwards there is a shift of maxima from 232mμ towards 210mμ where a new maxima starts appearing. In samples wherein there is no intramolecular reaction, there is no shift of maxima. The intramolecular reaction is studied by the Iodine value/Molecular weight relation of the sample during polymerization.

2. *Studies in Karela Seed Oil* (Momordica charantia Linn.).

K. K. Dole *and* V. A. Saraf, Poona.

Karela Seed Oil is a conjugated drying oil; it contains as much as 51·0% of the triene conjugated fatty acids. Karela Seed Oil possesses high refractive index (1·4950 at 40°C.), high unsaturation (I.V. (Wigs) 119·6; I.V. (Wöburn) 171·0), low acid value (2·1) and good colour. (Lovibond tintometer reading of the oil with
B R Y
10mm. cell= 0·0 1·0 10·0). Karela Seed Oil gives a tack free film with good alkali and solvent resistance.

Karela Seed Oil can be fractionated into two fractions with isopropanol. The two fractions differ little in unsaturation as revealed by the determination of their iodine values; this shows that Karela Seed Oil is a mixed triglyceride. The two fractions differ in acid values.

Thermal polymerisation of Karela Seed Oil can be more easily controlled than that of tung oil. The rate of polymerisation of Karela Seed Oil is quite rapid at 250°C. Karela Seed Oil is similar to tung and Oiticica oils in physical behaviour as indicated by the fact that the refractive index decreases in all cases with progressive increase in molecular weights.

3. *Chemical Examination of the Roots of Cocculus Leaeba DC.*

A. V. Subbaratnam, Aligarh.

The roots of Cocculus leaeba (syn. C. pendulus), are reported to be used in the indigenous systems of medicine in India in the treatment of intermittent fevers and in Senegal and French Sudan also, they are reported to be used in the cure of periodic fevers by natives. Studying the pharmacognostic characteristics of the roots of C. leaeba collected from Senegal, where the drug is called 'Sangol du Senegal', Beauquesne Bull. Sci. Pharmacol., 45 (1938) 7, reported the presence of palmatine (0·6 per cent) and another alkaloid.

As C. leaeba belongs to the N.O., Menispermaceae, a rich source of curariform drugs, it was considered of interest to undertake systematic examination of various parts of the plant. The present communication gives an account of the isolation and characterization of an intensely bitter, yellow crystalline substance, $C_{18}H_9O_7N$ (provisional) m.p. 280°C (dec.), besides the isolation of another bitter yellow crystalline product m.p. 245-48°C (dec.), and a tasteless, colourless product m.p. 226-27°C (dec.) and preliminary examination of the essential oil obtained as well from the roots. Alkaloidal constituents were found only in traces.

The yellow crystalline substance contains a carboxyl, a methoxyl and a substituted amido group (characteristic strong absorption bands with maxima at 6·08μ and 6·60μ in the infrared). Phenolic hydroxyl, methylene dioxy and carbonyl groups are absent. On decarboxylation (by heating with Cu and quinoline) a neutral, brown crystalline product, $C_{15}H_9O_8N$, m.p. 204-08°C (dec.) was obtained. On methylation with diazomethane the methyl ester, $C_{17}H_{11}O_7N$, m.p. 276°C (dec.) was obtained as fine yellow needles devoid of bitter taste. The methyl ester on reductive acetylation yielded a yellow crystalline product m.p. 300-02°C (dec.).

4. Studies on Oxygen Consumption by the Mould *P. chrysoquenum* during Penicillin Production in large fermentors.

D. GHOSH, Pimpri, Poona.

Production of penicillin by submerged fermentation is a highly aerobic process. The usual practice in commercial penicillin fermentation is to bubble through the fermentation medium as much as 0·5 to 1 volume of air per volume of medium per minute throughout the fermentation cycle lasting for 3 to 5 days. In a penicillin factory among the ancillary services supply of compressed air is a major item of fermentation expenditure. In shake flasks penicillin production goes on, though at a lower rate, with very little supply of air through the cotton plugs, whereas huge amount of air appears to be necessary for optimum penicillin yields.

No data is yet available in literature regarding the actual oxygen requirement of the respiring mycelial cells during active penicillin fermentation in large fermentors. With a view to economize the consumption of compressed air and to reduce the cost of aeration, actual oxygen consumption by samples of mycelial suspension withdrawn at different hours of fermentation from production tanks in the factory, was measured in a Warburg apparatus. The results indicated that the rate of aeration employed in the factory (0·7 volume of air per minute) was over twenty times the theoretical requirement of air necessary (0·03 vol. per minute) to meet the oxygen demand of the mycelial cells during penicillin production.

Trial fermentations were therefore conducted by cutting down the rate of aeration straightaway by over 50% i.e. from 0·7 vol. to 0·3 vol. per minute in paired tank and penicillin yields were compared at high and low aeration levels using the same seed inoculum and keeping other fermentation condition the same, as far as possible. The average penicillin yields were practically identical in high and low aeration conditions. The practical implications of these results were discussed.

Section V, Geology & Geography.

1. Geology of Parts of Krishna District (Andhra Pradesh) with special reference to Metamorphics.

G. DHANANJAYA RAO *and* A. NARASINGA RAO, Waltair.

The area forms the Northern half of sheet No. 65 D/6 and is the Western continuation of the Kondapalli hill ranges. The various rock types met with in the area include the schistose and gnessic series of rocks, charnockites, leptynites and other hybrid rocks, granites, basic intrusives and diamond bearing conglomerates. The area was mapped on a 1″ = 1 mile scale and representative specimens of the various rock-types were studied optically and chemically in the laboratory.

From a detailed field and laboratory study the schistose and gneissic rocks have been shown to be original sediments which were subjected to different grades of metamorphism. The ultrabasic and basic charnockites are recognized to be igneous in origin, while the intermediate type is inferred to be the result of some admixture of the granitic material with the basic types. Leptynites and garnetiferous hypersthene granulites are considered to be the products of hybridization and interaction between the older para-schists and gneisses and the charnockites.

The granite complex is surmized to be of igneous origin and the grey and pink varieties are considered to be the results of differentiation and injection of the several fractions of the melt at intervals.

The dolerites and lamprophyres (?) are basic intrusives and are presumably the youngest members in the Archaean complex.

The diamond bearing conglomerates lie unconformably over the Archaean rocks and are considered to be the extension of Banganapalle sandstones of Kurnool age.

2. Beneficiation of Low grade Manganese ores from Garividi—Garbham area, Visakhapatnam District, Andhra Pradesh.

A. NARASINGA RAO *and* C. MAHADEVAN, Waltair.

Low grade manganese ores from the Garividi-Garbham area, Vizagapatam District, are being investigated systematically with a view to upgrading the ores and also tackle the phosphorous problem using standard methods of mineral dressing.

Manganese ores containing more than 0·15 to 0·18% phosphorous, regardless of the manganese content, are not suitable for making ferro-manganese or other alloy steels and the Garividi ores contain variable amounts of phosphorous from 0·3% to 0·4%. The reduction of phosphorous content in these ores is therefore an essential first step if they are to be used for the manufacture of ferro-manganese.

The low grade ores assay about 20-22% of Mn and about 0·35% phosphorous on an average. Jigging, screening, tabling, electromagnetic separation and flotation have been successfully used for the beneficiation of these ores. The Mn content is enriched to a satisfactory degree, but the reduction of phosphorous is not good enough to be satisfactory. Further work on the phosphorous reduction by differential flotation is in progress.

3. Geology and ground-water conditions in Azamgarh-Ballia region, eastern Uttar Pradesh.

B. D. PATHAK, Calcutta.

The paper describes the results of geohydrological observations made in Azamgarh-Ballia region, eastern Uttar Pradesh lying between the latitudes 25°30′ and 26°22′ north and longitudes 82°50′ and 84°15′ east covering about 4,000 square miles.

The area is underlain by alluvial deposits of Pleistocene to Recent age. The deposits consist of clay, clay with kankar, sandy clay, silt, fine-, medium- and coarse-grained sand and sand with kankar. Records of the sub-surface distribution of alluvial deposits in this region indicate that the large modern rivers, the Ganga and Gogra, have been the principal agents of deposition during the development of the sedimentary sequence in the upper 300 feet of the deposits. The distribution of the meander belt and backswamp deposits determine the availability of the groundwater in the region.

Groundwater in the water-table aquifer is derived mainly from local rainfall, whereas that in the confined aquifer is derived from the water-table and the aquifer and the principal streams. The pattern of the water level contour for May-June 1955 indicates that the general flow of the ground water is from west to east. Locally the direction of flow is transverse to the drainage. There are three prominent groundwater ridges shown by the water level contours. The groundwater valleys coincide with the main drainage courses of the region while streams are at low stage.

163 tubewells were inventoried during the investigation. The static water level in the tubewell ranged from 11 to 32 feet below land surface when measured in

January 1955. The discharge rate of the tubewells measured during the same period ranged from 10,000 to 38,000 gallons per hour. The specific capacities of the tubewells for which discharge and drawdown measurements were made ranged from 10 to 46 gallons per minute per foot of drawdown.

Detailed studies of the water level fluctuations made by installing an automatic water level recorder on a shallow dug well indicate that the fluctuations recorded show the effect of pumping from a neighbouring tubewell, effect of change in atmospheric pressure, and long term changes in groundwater storage.

The partial chemical analyses made of 133 water samples from shallow dug wells and 97 water samples from tubewells indicate that the ground water is in general low in chloride and high in bicarbonate and total hardness. Generally the ground water is ideally suited for irrigation of crops.

4. A note on artesian water in Kachhars of Yamuna river, District of Etawah, Uttar Pradesh.

B. D. PATHAK, Calcutta.

The paper describes the artesian conditions of aquifers that underlie low terraces (locally known as Kachhars) adjacent to Yamuna river in Dalipnagar area (26°36′ : 79°11′) in Etawah district of Uttar Pradesh. Tubewells drilled here to depths of 158 to 234 feet tap water under artesian pressure. Some wells flow naturally at the land surface and in others the water level rises to within a few feet of the land surface, so that lowlift pumping is feasible.

The tubewells constructed in the area have maximum depth of 234 feet and penetrate beds of clay and water bearing medium- to coarse-grained sand with fine-grained gravel. The ground-water which occurs in the alluvium of Dalipnagar area is sustained and recharged each year, partly by rainfall and partly from infiltration from the Yamuna river. The data collected during the geohydrologicl investigation are not sufficient to enable determination of the nature and amount of this replenishment. The shallow ground water near the land surface in the aquifers of the alluvium of Dalipnagar area occurs under water table conditions. The lithologic logs of the flowing tubewells indicate that confined aquifers lie between depths of 61 and 142 feet below land surface.

The pressure head in the tubewell ranged from 1 to 6 feet above land surface when measured in early March 1954. The natural flow of the individual wells ranged from 28 to 100 gallons per minute. The water from these wells is used for irrigation.

Tubewells to be drilled in the future in the area should be spaced about half a mile apart to minimise the water level interference between wells. The wells should not be allowed to flow when the water is not being used. Where the flow from the well is insufficient, water may be pumped mechanically for irrigation. The *kachhars* exceeding 1,000 acres in area should be explored for confined ground water conditions by boring exploratory wells at suitable locations.

Section VI, Botany.

1. Further studies on the control of Loose Smut of Wheat in the Punjab.

KISHAN SINGH BEDI, Ludhiana.

In respect of the solar heat treatment, which is being carried out on an extensive scale against loose smut of wheat in the Punjab, a notion has been entertained by the members of the Agriculture Department of this State that the soaked seed wheat has necessarily to remain under the influence of solar rays for a number of hours, not less than four. It is thought that, if the weather during the period of exposure to the sun becomes windy or cloudy, the treatment remains incomplete. Regular experiments carried out during the months of May and June in the years 1952, 1953 and 1954 at Ludhiana have consistently shown that after a pre-soaking period of 4 hours in water of seed wheat, only one hour's exposure to solar heat is enough to devitalize the intraseminal mycelium of the loose smut fungus, *Ustilago tritici.* The rest of the exposure to sun's rays constitutes only the drying process. No fears with regard to the effectiveness of the solar treatment in the plains of the Punjab during the months of May and June may be entertained, if the soaked seed wheat becomes exposed to the sun's rays even for a period of about 1 hour. Subsequent to this exposure, windy or cloudy conditions of the day will not impair the effectiveness of the treatment.

Even a 5 minutes' exposure of soaked seed wheat at 12 noon is quite effective in reducing loose smut infection.

The mere process of soaking seed wheat in ordinary water at room temperature and drying it in shade is also not without effect. Under the conditions of the experiment, this process reduced the amount of loose smut infection by about one-third in a number of trials. This is remarkable. This evidence also substantiates the observation made by intelligent farmers that the wheat produce becoming moist as a result of rains, while on the threshing floors, becomes automatically free from loose smut infection to an appreciable extent.

2. Plant remains recovered during sinking of piers for construction of Ganga bridge, Mokameh, Bihar.

K. A. CHOWDHURY *and* S. S. GHOSH, Dehra Dun.

The Chief Engineer, Ganga Bridge sent to us 11 different pieces of wood remains that he came across while sinking wells for the construction of piers at Hatidah, Mokameh. Details of the remains with locality and identification are given below :—

Date on which sent	Particular of remains	Number of pieces	Identification
20-2-56	From an island in the river, well No. 15.	2	*Acacia* spp.
1-3-56	Well No. 14.	2	*Dalbergia latifolia*
19-3-56	Well No. 2.	2	*Dalbergia latifolia.*
2-4-56	Well No. 11.	1	*Dalbergia latifolia*
27-9-56	South Bank of river, Well No. 1.	4	*Ficus* spp. *Pinus excelsa* (syn. *P. wallichiana*) *Acacia* spp. *Dodonaea* spp.

The most important point, in which the Chief Engineer was interested, was whether these plant remains were embedded recently or some time in a remote age. Our researches on embedded wood remains of India have given us some data on rate of decomposition of these materials. Based on these, we are of opinion that these wood remains are thousands of years old. They are not recent. This information was of considerable importance to the Chief Engineer, for wood remains of recent origin at such a depth of the river would have indicated a modification of original plan of the bridge. He would therefore now go ahead with the construction work.

From the botanical point of view, the remains of *Dalbergia latifolia* indicate much more frequent occurrence of this species than it is today. Evidently this tree has migrated to more suitable environment than the present Mokameh within the last thousands of years.

Lastly, the remains of *Pinus wallichiana* is of interest. Could there have been a climate at Mokameh during older Alluvium for *P. wallichiana* to grow there? As far as our information goes at present, there is no such indication. The log of *P. wallichiana* must have come down from the Himalayas and got embedded in the then river bed.

3. A study of the scrub jungle at Tirumailadi.

K. K. Easwaran, Annamalainagar.

A study has been made of the scrub vegetation at Tirumailadi (Tanjore District) which is very unique in the sense that the dominant species are bigger trees like *Bassia latifolia* Roxb. and *Borassus flabellifer,* L. under whose shades alone are restricted other species of the community. They are mostly shrubs and dominants in the shrub stratum are *Memecylon umbellatum* Burm. f., and *Glycosmis cochinsinensis* Pierre. etc. Unlike in other scrub jungles here the succulents and thorny species are rare. During rainy seasons the whole floor of the vegetation get inundated with water and the water gets stagnated for days together in the shallow areas to a depth of one and a half to three feet. This peculiar feature and the resultant changes in species adds further interest. Plants like *Geniosporum prostratum,* Benth. and *Marsilea quadrifolia,* L. will be having now a hydrophytic existence as they will be completely submerged: They are thus subjected to an extremely dry season druing summer and a wet season during winter. Thus the species are having Tropophytic existence.

Seasonal root-studies reveal that in correlation with the fluctuating water-table all the species in the vegetation whether herbs or trees, produce surface feeding roots during the winter. They are highly branched and wiry. They lie just below the uppermost layer of the soil and may even come out. They are of ephemeral duration. And once the water gets receded, these roots die off.

From the consecutive periodic studies made based on the standard methods, as well as from the collection of data from the Department of Botany from 1948 to 1953 it has been possible to conclude that the vegetation at Tirumailadi has almost become stabilised and it is not in seral stage. And this stabilisation is due to the edaphic influence and it is an "Edaphic Climax".

4. A Comparison of some of the flowering characters of the parents and the hybrid-*Datura inoxia* Mill. x *Brugmansia suaveolens* Humb. & Bonpl. and *D. inoxia* Mill. x *B. aurea* Saff.

P. C. Joshi, Chandigarh.

Reciprocal crosses between the species of *Datura* and *Brugmansia* (Tree Daturas) are ordinarily incompatible. It was, however, observed that some fruits developed on *D. inoxia* Mill. plants when crossed with *Brugmansia suaveolens* Humb. & Bonpl. or *B. aurea* saff., but no viable seeds were ever formed. Some of the capsules resulting from these crosses developed a few immature embryos which left on the plant died after sometime. Some of these hybrid embryos, before they started disintegrating, were dissected out of the capsules and were cultured *in vitro*. In this way the two intergeneric hybrids, *D. inoxia* × *B. suaveolens* and *D. inoxia* × *B. aurea* were obtained.

A comparison was made of the following well contrasted flowering characters of the parents and the hybrids :—(1) the flowering periodicity, (2) the period for which the flower stays open, (3) rate of increase in corolla length, (4) change in the position of the flower, (5) persistence of ovary of the unpollinated flower. In flowering periodicity the hybrids resemble more like the *inoxia* parent. The hybrids are intermediate between the parents for the duration of the opening of the flowers and the rate of increase in corolla length. The hybrids resemble the ***Brugmansia*** parent in the change in position of the flower axis during its development and early falling off of the ovaries of the unpollinated flowers without undergoing any enlargement.

5. On the hypogeal and epigeal germination of the seeds in the family Leguminosae.

S. KALYANASUNDARAM, Annamalainagar.

This study comprises 200 species spread over 58 genera of the Leguminosae. Intensive observations have been made on the germinating seeds in respect of the hypogeal and epigeal nature of their germination. The distribution of these two types of germination through the Leguminosae is of interest. The sub-family Papilionaceae shows both hypogeal and epigeal types of germination. In Caesalpinieae the epigeal type predominates and hypogeal germination occurs only in few species. In Mimosae the germination is strictly epigeal. The greater frequency of hypogeal germination in Papilionaceae as compared to Caesalpinieae and the total absence of hypogeal germination in Mimoseae suggest that the hypogeal condition may have been the ancestral type of germination of Leguminosae and that the epigeal condition has been derived from the hypogeal ancestors.

The present study lends further support to my view that the Papilionaceae is the most primitive in its vegetative ontogenetic evolution and Mimosae the most advanced, Caesalpinieae occupying a mid-position (*Proceedings Indian Science Congress Association*, 1955, p. 227).

6. "Morphological and Physiological studies on tuberous roots of some common plants of the Indian desert".

J. N. KAPOOR, Bikaner.

A detailed study of the tuberous roots of ***Daucus carota, Raphanus sativus, Asparagus racemosus, Withania somnifera, Datura stramonium, Boerhavia diffusa*** and ***B. repanda*** was undertaken and following observations were made :

(1) Physical nature of the soil, such as temperature and pH value of the soil do not materially affect the nature and extent of tuberisation.

(2) Presence of less humus in the soil favours tuberisation.

(3) The presence of Potassium, Calcium and Magnesium and Phosphates enhances tuberisation.

(4) Lack of Iron enhances tuberisation to an appreciable extent.

(5) The most important ions in order of preference which favour tuberisation are (*a*) Potassium, (*b*) Calcium and (*c*) Magnesium among the cations, and (*a*) Phosphates and (*b*) Nitrates amongst the anions.

The above observations indicate that tuberisation is a phenomenon controlled by the minerals supplied to the root system.

7. Studies in the family Vitaceae. 11. Floral anatomy of *Vitis trifolia* Linn., *Vitis latifolia* Rox. and *Vitis himalayana*, Brandis.

GANDHARI KASHYAP, Ajmer.

The floral anatomy of three species of *Vitis*—*V. trifolia, V. latifolia* and *V. himalayana* has been studied. Flowers are borne in dichasial cymes. Bracts and bracteoles are present in *V. latifolia*. Flowers in *V. trifolia* and *himalayana* are tetramerous; pentamerous in *V. latifolia*. However, the following exceptions have been noted: trimerous flowers occur in *V. trifolia;* tetramerous in *V. latifolia;* pentamerous in *V. trifolia* and *V. himalayana,* and hexamerous in *V. latifolia.* Sepals are reduced to a rim, are vascular in *V. latifolia* only; being non-vascular in other species rules out the doctrine of the conservatism of the vascular supply. The traces for petals, stamens and carpellary dorsals arise conjointly in *V. trifolia* and *V. latifolia.* In *V. himalayana,* however, the dorsals arise independently. Stamens are antepetalous. Disc is congenitally confluent with the ovary wall, and it appears to be receptacular. Flower is slightly perigynous and tendency towards epigyny is revealed in *V. trifolia.* The bilocular condition of the gynoecium is suggested to have been derived from a multilocular one. Tri- and tetra-carpellary gynoecia also have been noted in *V. latifolia.* The carpellary ventrals divide to give ovular traces, one on either side. Rarely the ovular traces branch to give the placental supply. Departure of the additional ovular traces in one case justifies the disappearance of additional ovules. Anatomically the placenta appears to be parietal.

8. On the occurrence of diatoms in the leaf of *Spirodella polyrrhiza,* Schleid.

G. LEELAKRISHNAN, Annamalainagar.

While investigating the anatomy of the leaf of *Spirodella polyrrhiza,* diatoms were found to occur in the intercellular spaces and cavities of the mesophyll, as also intracellularly in the cells of the epidermis, palisade parenchyma and the spongy parenchyma.

These diatoms are of semi-lunate configuration with a prominent raphe exhibiting sluggish movement. The youngest leaves had either no such diatoms in their mesophyll or at best had only a few of them. In the adult leaves the number of diatoms was much greater. In the oldest leaves, which exhibited senesence by their yellow colour, the occurrence of the diatoms was the greatest, the mesophyll being fully packed with them. The role of these diatoms in the metabolic economy of the life of *Spirodella polyrrhiza* is not very clear but *prima facie* it appears to be one of predation.

9. A suggestion to improve the floral diagram and floral formula with particular reference to the Gynoecium.

G. LEELAKRISHNAN, Annamalainagar.

The floral diagram represented in the modern work on Systematics appears to be incomplete in so far as there is no representation exhibiting hypogynous, perigynous and epigynous conditions of the gynoecium; similarly in the floral formulae there is no symbol to represent the perigynous condition.

In order to remedy the discrepancies the following suggestions have been made with a view to invite constructive criticisms and suggestions.

1. The hypogynous nature of the gynoecium may be represented by the usual normal floral diagram.

2. The perigynous condition of the gynoecium may be represented by concentrically drawing a circle round the usual normal gynoecium representation. This will obviously explain the fact that the ovary is inside the thalamus-cup without any fusion.

3. The epigynous condition may be represented exactly as in the perigynous condition except for the fact that the fusion of the ovarian wall with that of the thalamus may be represented by connecting them with cross-hatchings.

4. Hypogynous gynoecium is usually represented as G. The epigynous condition is represented as G. I suggest that the perigynous condition may be represented as G.

10. White flowered mutant of *Brassica juncea* H.

U. K. RAI *and* K. T. JACOB, Calcutta.

Dry seeds of Rai 5 (*Brassica juncea*, $2n=36$) were irradiated with an X-ray dosage of 26,000 r. In the X_2 progeny, a selection, gave a morphological mutant with white flowers. Though the mutant plants were comparatively shorter in height than the control; They had greater number of branches and gave increased yield of fruits, as against the control and other selections from the same treatment. This mutant has larger pollen and greater pollen sterility than the control. As regards the survival percentage of plants, time and duration of flowering, no significant differences between the mutant and the control have been obtained. The selfed progenies of the white flowered mutant were all white flowered. But when crossed, it segregated in the ratio of 15 : 1 approximately. This is generally the case in polyploids and arises by the duplication of genes which originally existed singly, and which is applicable in the present case also, since *Brassica juncea* has an amphidiploid origin.

11. Afforestation in Saline Tracts of Rajasthan.

SHANTI SARUP *and* K. D. RAMDEO, Bikaner.

Afforestation of arid zones of Indian desert should not be restricted to tree planting but some species of shrubs should be used to stabilise the loose soil. A study of the following areas of Rajasthan shows that some species grow there with advantage :

(*i*) Sambhar lake. (*ii*) Didwana lake. (*iii*) Pachpadra lake. (*iv*) Luni river bed.

The climatic factors, edaphic factors and floristic composition of the area were investigated. The climatic factors in West Rajasthan present extremes of conditions, characterized by low rainfall, high temperature ard stormy winds during many months of year.

The soils of these areas are primarily sandy-loamy, single grained in structure and characterized by the formation of Sodium chloride patches, the percentage is recorded to be above 77%. The percentage of water soluble salts and soil reaction show very abnormal value (·48 to 1·75 and 10 to 10·5 respectively) which are considered to be limiting factors for plant growth.

The study of floristic composition reveals the presence of ephemerals and tree species; the former vanish with the approach of winter as salinity values show a marked increase and their life cycle is completed. Some trees are resistant to salinity or may prove successful for afforestation purposes, The following plants which are already present may be encouraged to grow in the areas to advantage :—

A. Banks of Luni river :

North Bank (the Railway Station)—soil loamy : (*a*) *Salvadora persica.* (*b*) *Solanum indicum.*

South (Opposite) bank—soil sandy : (*a*) *Aerua tomentosa.* (*b*) *Tephrosia purpurea.*

B. In the bed off Luni river : (*a*) *Tamarix disceca.* (*b*) *Tamarix gallica* var *articulata.* (*c*) *Pluchea lanceolala.*

C. At the fringe of lakes : (*a*) *Tamarix gallica* var *articulata.* (*b*) *Tephrosia purpurea.*

12. Chromosome number and morphology of some species of *Vigna.*

Nirad K. Sen *and* J. G. Bhowal, Kharagpur.

The three commonly cultivated types of *Vigna* : the asparagus bean, the cowpea and the catjang bean are considered as distinct species viz. *V. sesquipedalis,* Frewirth, *V. sinensis* Savi., and *V. catjang* Walp for their conspicuous morphological differences, or, are grouped in a single species *V. sinensis* Endl. and the asparagus and the catjang beans are then considered as two subspecies viz. sesquipedalis and catjang or cylindrica. Chromosome numbers for *V. sinensis* and *V. sesquipedalis* have been reported as $2n=24$, and for *V. catjung* as $2n=22$ & 24.

The chromosome complement in the three cultivated asparagus beans, three cowpeas and in one catjang bean types studied so far, showed the same chromosome number of $2n=22$ in all of them. Very little difference could be observed in their chromosome complements. The chromosomes are small about 1·9 to 3·8μ long with nearly median or submedian primary constrictions and can be divided into 3 groups with one pair of long chromosome, 6 pairs of median and 4 pairs of small chromosomes.

In the three wild species of *Vigna* viz. *V. parviflora,* Welw. *V. davyi* Bolus and *V. willmsii,* Burtt Davy, there are also $2n=22$ chromosomes, which can be similarly grouped into one long, 6 medium and 4 short chromosome pairs.

13. Interspecific crosses between *Phaseolus aureus* L. (green gram) and *Phaseolus mungo* L. (black gram).

Nirad K. Sen *and* A. K. Ghosh, Kharagpur.

It has been possible to hybridize between *Phaseolus aureus L.* (green gram) and *P. mungo L.* (black gram) reciprocally. The hybrid seeds are small wrinkled containing comparatively little food matter. Most of the hybrid seeds failed to germinate. The few F_1 plants that grew, collapsed at different stages of growth. They were weak, slow growing and showed the black gram characters mostly. The only plant that grew to maturity was highly sterile and developed only two small pods. It has, however, been possible to backcross the plant to the green gram parent, using the latter as the female parent. Though the sterility in the hybrid was very high meiosis was more or less normal with regular pairing of the 11 chromosomes of the parent. Loose pairing of a pair of chromosomes often resulted in some meiotic irregularities.

14. Cytology of *Holarrhena antidysenterica* Wall.

NIRAD K. SEN *and* N. N. ROY TAPADAR, Kharagpur.

In Holarrhena antidysenterica Wall of the Fam. Apocynaceae commonly known as "Kurchi" there are 22 chromosomes. The mitotic chromosomes are small (1—2·7μ) with median or sub-median primary constriction. There are two pairs of chromosomes with satellites. Meiosis is normal with the regular pairing of chromosomes forming 11 bivalents.

15. Colchicine induced tetraploid guar (*Cyamopsis psoralioides*) types.

NIRAD K. SEN *and* R. V. VIDYABHUSANAM, Kharagpur.

Seeds and seedlings of four guar types grown for vegetable and fodder were treated with aqueous solution of colchicine of various concentrations and for different durations. The treated plants grew slowly and the majority of the young seedlings exhibited abnormalities, such as, curling, twisting and lobing of leaves. Often the first leaf developed mosaicism. In the seedling treatments the cotyledon pairs grew bigger and thicker.

Suspected tetraploids from the treated plants were picked up on the basis of their pollen sterility. They were shorter and had few short branches, thicker leaves with fewer but bigger stomata. Flowering of the tetraploid plants were delayed. Number of flowers per inflorescence were considerably less and the floral parts are bigger than the corresponding parts of the diploids. Petals were comparatively lighter in colour. Pollen sterility were very high, pollen production scanty and fruit setting in most of the plants were rare.

Meiotic study of the suspected plants made so far confirmed their tetraploid nature in the types Hyderabad long pod, BR 1 and Punjab 3. At diakinesis and metaphase I different types of chromosome association and some irregularities at anaphase I were seen. Varietal differences were observed in pairing of chromosomes and subsequent chromosome irregularities.

16. Studies in the effect of moon-light (Lunoperiodism) on the growth and reproductive phase of plants-III.

T. C. N. SINGH, Annamalainagar.

There is no work on the effect of moon-light on the growth of plants except by the author himself (Singh, T. C. N., *Proc. Indian Sci. Cong.* 1955 and 1956) who has experimented on *Bryophyllum calicynum* Salis., *Manihot utilissima* Pohl., *Althaea rosea* Cav., *Impatiens balsamina* Linn., *Saccharum officianarum* Linn., *Lycopersicum esculentum* Mill, *Zinnia elegans* Linn. and *Petunia hybrida* Linn.

In the present investigation experiments were repeated on *Bryophyllum calicynum* Salis, *Manihot utilissima* Pohl. and *Saccharum officianarum* Linn. and the same was extended to ten strains of tobacco obtained from Central Tobacco Research Station, Rajamundry.

The results in respect of the first three species have been found to confirm fully, the previous observations, namely, *Bryophyllum calicynum* Salis. and *Manihot utilissima* Pohl. are positively responsive to moon-light and *Saccharum officianarum*, Linn., is negatively so, namely its growth was found to be more vigorous in the absence of moon-light. The results in respect of Rajamundry tobaccos are equally interesting namely, all of them except Yellow Special (which succumbed to certain disease in the progress of experimentation) are positively responsive to moon-light in respect of their vegetative and reproductive phases. But the highest height percentage of over 60 was attained by Golden Wilt, highest percentage increase of leafiness of about 70 was exhibited by the same strain and Golden Harvest and the highest production of flower of the order of 90% was scored by Bottom Special. The greatest earliness of 24 to 37 days was found in the case of Virginia Bright.

17. Preliminary observations on the effect of Solar and Lunar Eclipses on the growth of plants.

T. C. N. SINGH, Annamalainagar.

Well-established young plants of *Bryophyllum calycinum, Ipomoca batatas, Phaseolus mungo, Dolichos biflorus, Vinca rosea,* and *Hydrilla verticillata* were exposed directly to the last Sun-eclipse throughout its entire period; similarly, young well established plants of *Bryophyllum calycinum, Canna indica, Vinca rosea, Nicotiana tabacum* and *Mimosa puica* were exposed directly to the last Moon-eclipse during its entire period. In each of these cases proper controls were maintained by shading them away from the direct light of the eclipses. Subsequently both the experimental and control plants in their ontogeny have been maintained under identical conditions.

It is interesting to report preliminarily that the vegetative growth of all the eclipse-exposed plants have been found to be less vigorous than the control; and in fact the eclipse-exposed plants of *Phaseolus* and *Dolichos* died off outright without their entering into their reproductive phase. The submerged *Hydrilla verticillata,* however, remained unaffected, but curiously enough the eclipse-exposed sensitive *Mimosa pudica* in its vegetative performance was found to be superior to its control. Further work is in progress.

18. Study of plant-succession in the Botanic Garden at Annamalainagar, by the 'Transect' method.

T. C. N. SINGH *and* K. K. EASWARAN, Annamalainagar.

One of the standard methods of studying vegetation is by Line-transect; and this method has been employed in the Botanic Garden at Annamalainagar, in recording the floristic composition, ecesis, seasonal fluctuation, competition and succession of species. The present paper is the summation of the results of fortnightly observations during the years 1951-56.

The Line-transect under investigation has a length of 300 ft. This line is maintained permanently by means of pegs and the progressive invasion of new species, their competition between the existing ones, the seasonal fluctuations of the individuals and their succession were all studied. The summary of the results show that for the successful growth of *Cyperus rotundus* and *Clitoria ternatea* optimum temperature and humidity are most favourable and that extreme temperature and continuous rains do not promote their growth or succession. These two species fluctuate during seasons. It is of especial interest to note that *Rottboellia myurus* with its caespitose and perennial habit is typical heliophilous species and it cannot endure shade at all for a successful growth, whereas *Ruellia tuberosa* is a heliophobic species.

By regular sequences in the line of succession a thick bush has been formed in this Line between the last three pegs. All the species are heliophobic and *Rottboellia* is completely absent in this zone.

19. A comparative anatomical study of the parasitism of Orobanche.

JAWAHAR LAL WAKHLOO, Bhagalpur.

Orobanche cernua reported to parasitise wheat N.P. 52 cultivated as a mixed crop with *Brassica campestris* var. *Sarson*, and *O. indica* parasitising *Launea pinnatifida* formed the material for the study. The initial stages of the parasitisation of the two hosts were found to be similar. Haustoria are rarely developed and the area of contact is extensive. The epidermis and the cortex of the host are dissolved and the cortical cells of the parasite near the contact region become meristematic and by rapid successive divisions in tangential plane form a compact tissue in *O. indica*. Vascular tissue soon differentiates and connexion with the vascular tissue of the host is established.

In *O. cernua* found on wheat the cortical cells in the region of contact elongate tangentially becoming palisade like. After the dissolution of the extra-stelar tissues of the host the palisade cells come in contact with the endodermis. Subsequently finger like projections are given out which grow round the endodermis apparently to break it open. In several cases the entire cortex of the host root was found to have dissolved with no perceptible damage to the endodermis which was completely encircled by the proliferated cortical cells of the parasite. Rarely a few vascular elements differentiate but since no vascular connexion is established with the host these are obviously functionless and the only way the parasite can obtain nourishment is by diffusion through the endodermal cells which clearly cannot be adequate as *Orobanche* is a total parasite devoid of chlorophyll. This suggests that *Orobanche* may not be able to parasitise wheat successfully. Similar conclusions are drawn from the experiments conducted to test the germination of its seeds. In a series of such experiments it was observed that while germination occurs easily when the seeds are in contact with the roots of mustard (or any established host) they fail to germinate in contact with wheat or otherwise and in these stray cases the seedlings perished at a very young age. It is concluded that wheat may not be an established host of *Orobanche* the seeds of which germinate when in contact with the roots of mustard and may subsequently parasitise the neighbouring roots of wheat in a mixed crop. This also explains the total absence of *Orobanche* from fields planted with wheat only.

20. A comparison of the flora of Puerto Rico and the Lesser Antilles with that of Ceylon.

ISMELA VELEZ, Colombo.

A comparison of the flora of Puerto Rico and Lesser Antilles with that of Ceylon, keeping in view the geographical position, climate, topography and geological history of the two regions, shows that, in spite of the expected contrasts, there are many similarities. In Puerto Rico alone, where there are about 3,000 native and naturalised species, a conservative estimate shows that there are about 500 genera and 400 species in common with Ceylon. For the whole area the number probably approaches one thousand. Of the 500 most common weeds of Puerto Rico, recorded in a recent book (Vélez 1950 : Plantas Tropicales. University of Puerto Rico), about 75% of the genera and 50% of the species are also found in Ceylon.

21. Anthocyanin from Commelina Communis.

S. HATTORI, Japan.

It is a matter of question whether or not blue flower petals have two or more than two blue colouring matters as the cause of their colour.

We have obtained a *crystalline* blue colouring matter from the flower petals of *Commelina communis*, a wild commelinaceous plant of Japan, which is composed of an anthocyanin plus Mg and K. The remarkable character of this blue colouring matter lies in that it is very, but not absolutely, stable in an aqueous solution of *acid* side, as low as pH 4. This property suffices its stability in *acid* cell sap where anthocyanins are present without exception.

Section VII, Zoology & Entomology.

1. Use of free-living amoebae in screening amoebicidal compounds.

B. S. KAUSHIVA, Lucknow.

The possibility that free-living amoebae might be found useful for *in vitro* screening of amoebicidal compounds has been suggested. If, in fact, the sensitivities of *Entamoeba histolytica* against different amoebicides could be correlated with that of other amoeba, the latter may be able to replace *E. histolytica* as a test organism thereby avoiding the difficulties associated with the present use of *E. histolytica*. However, the use of an amoeba other than the causative agent may be criticized on the ground that wide differences exist among the amoebae in their susceptibilities to chemotherapeutic agents and new uncertainties enter when the actual pathogen is not used. In order to elucidate the problem whether any of the free-living amoebae could be relied upon in obtaining information applicable to *E. histolytica*, a comparative study of the sensitivities of three free-living aboebae (*Naegleria gruberi*, *Schizophyrenus russelli*, and *Didascalus thorntoni*) against 56 potential anti-amoebic compounds has been made and the results are presented in this paper. Such a study also provides a background for bringing out the physiological differences between pathogenic and non-pathogenic amoebae.

2. Studies on activities of Earthworms.

SUBODH K. ROY, Calcutta.

This investigation has been undertaken to provide information on the activity of earthworms under two ecological conditions prevailing at Baranagore, Calcutta (West Bengal) and Giridih (Bihar).

Morphologically distinguishable castings of two different kinds of Earthworms (*Eutyphaeus waltoni* and *Pheretima posthuma* respectively) were examined. From the distribution of the castings over the field it appears that *Entyphaeus waltoni* is a light-tolerant, light-indifferent or light-loving species unlike *Pheretima posthuma* which seems to be photo-sensitive or shade-loving. That there is a considerable variation in the total annual weight of castings from place to place and even from plot to plot in the same area is undoubted. The range of cast production between plots per year at Baranagore was (9-89 tons/acre). The mean value of the quantity of castings thrown up per year at Baranagore was 31·02-6·08 tons/acre or 12·76-2·50 megagrams per hectare while it was 1·40-0·51 tons/acre or 0·47-0·21 megagrams/hectare at Giridih. The latter figures are the lowest ever recorded.

No significant difference could be detected on the per hour activity of earthworms in the experimental plots at Baranagore during day and night. Hence the author is not in agreement with the generalised statement that earthworms are nocturnal in habits.

3. A natural bird sanctuary in the Sundarbans.

Ajit Kumar Mukherjee, Calcutta.

The present paper deals with a brief account of a natural bird sanctuary in the Sundarbans, West Bengal, hitherto unrecorded. The author observed that with the advancement of land reclaimation in Sundarbans, the biotic equilibrium has been upset resulting into shifting of the breeding grounds of birds to the reserve forest. Such a breeding colony was discovered in the forest block Sajnakhali of Pirkhali range, 24-Parganas forest Division where birds enjoy an unimpaired life.

Sajnakhali is an island of roughly 1250 hectares crisscrossed by sluggish creeks with pools and swamps. The island sustains a typical marshy flora with stunted trees and shrubs. The colony is monopolised mostly by waterbirds such as egrets, herons, cormorants, storks, ibises, lapwings, plovers etc. Their nest building operation ranges between July to October. It was interesting to note that the time of breeding varied among different related species and birds of the same species generally preferred to nest on the same tree till there was no overcrowding. An analysis of population of 5 species of birds breeding on a single tree is given.

4. Cytology of the alimentary tract of *Pherctima Posthuma*.
I. Golgi Material.

S. Keshava, Patna.

The present work was undertaken to study the cytology of the alimentary canal of an invertebrate animal, and to determine the relationship, if any, between morphology and disposition of the Golgi material and the phases of the secretory cycle. As the alimentary tract of *Pheretima* is divided into several distinct regions, it was considered a suitable material for investigation. For studying cellular changes during different phases of secretory cycle, certain specimens were starved prior to fixation while others were fed subsequent to starvation and thereafter examined at different stages. Much work exists on the histology of earthworm including *Pheretima,* but cytology of alimentary tract of *Pherctima* has not been studied previously.

Golgi material in the cells of the gut-epithelium consists of filaments, rods and granules. The functional stage is marked by hypertrophy of the Golgi material leading to its fragmentation into granules which surround the early secretory granules. Earliest secretory granules first appear in the basal cytoplasm. Morphology and disposition of Golgi material is correlated with various physiological stages of the cell and plays vital role in elaboration of secretion in gland cells. The detailed structnre and disposition of Golgi material during different physiological phases have been discussed.

5. Amounts of DNA in the Secretory cells (Silk glands) of some spiders.

N. B. Inamdar *and* U. V. Wagh, Bombay.

Desoxyribose Nucleic Acid (DNA) is estimated in different secretory cells of silk glands in 2 spiders (1) *Nephila maculata* and (2) *Thrigmopoeus insignis supli.* Estimation is made on Feulgen stained preparations by . microspectrophotometric methods. Results show that the quantities of DNA in different secretory cells (silk glands) of each organism are constant though nuclear sizes vary.

6. Some studies on the epicuticle of some Indian scorpions.

M. B. LAL *and* S. C. SHRIVASTAVA, Lucknow.

Histochemical and biochemical tests carried out on the epicuticle of the scorpions *Palamnaeus bengalensis* and *Buthus tamulus gangeticus* indicated the absence of chitin from the epicuticle of these scorpions although Lafon (1943) suspected the presence of chitin in the epicuticle of scorpions and Krishnan, Ramachandran and Santhanam (1955) suggested that the epicuticle of the scorpion, *Palamneus swammerdami* to be chitinous.

X-ray diffraction studies carried out on the epicuticle of *Palamnaeus bengalensis* and *Buthus tamulus gangeticus* also support the results of histochemical and biochemical tests regarding absence of chitin in the epicuticle of these scorpions.

These observations are in confirmity with Richard's definition (1951) of the epicuticle of the Arthropodan cuticle.

Section IX, Medical & Veterinary Sciences.

1. "Splanchnic anatomy of an Indian Elephant".

K. R. ALUR, Bombay.

Introduction :—History of the elephant—object of recording the case—rarity of the specimen—surface anatomy—cutaneous measurements and their relation to conformation—weight of the elephant—object of destroying the animal—various methods of destruction—shooting of the subject—reaction of the ammunition used in this case.

Method of dissection :—Instruments used for dissection—flaying of the subject and use of skin—return of skin to the Victoria gardens for tanning—dismembering of the various parts—method of opening the thoracic and abdominal cavity—disarticulation of ribs.

A short description of the anatomy of the head parts, as a whole—trunk and its relation to nasal cavity—peculiarities of the tongue—parotid gland—larynx and trachea.

Anatomy of the thoracic organs and their contrast to the mammalian organs—special features of the lung—size and variation of the heart.

A brief description of the thorax and abdominal cavity—abdominal viscera—diaphragm—stomach—a rare form of conformation—its divisions varying from equines and bovines—small intestines with special reference to the duodenum—large intestines—measurements of the same—spleen, its relations and peculiar formation—kidneys—liver and pancreas.

Anatomy of the female genital organs—its modification due to captivity—a short description of ovary and fallopian tubes—uterus and its peculiarities—external genitalia.

Section X, Agricultural Sciences.

1. Influence of winter rain on the grain yield of Wheat Crop.

P. S. SREENIVASAN, Poona.

The period of grain development in wheat crop is an important phase. Any rain during this period is bound to influence the final yield of grain, especially when it is cultivated as a dry crop. In this paper an attempt is made to evaluate the effect of rain during this period of grain formation of the wheat crop cultivated in Nagpur and Jalgaon under dry conditions. Also the chances of bringing about the winter rain by artificial methods in these tracts have been briefly referred.

2. "Variation in Protein Content of Wheat Grains".

P. S. Sreenivasan *and* V. S. Sarma, Poona.

The nutritive value of wheat depends to a large extent on the protein content. From a study of protein content in wheat grown in various farms in India under the co-ordinated crop-weather scheme, Central, it was found that the average percentage of protein in N.P. 4 variety of wheat varies from 10·8 in Powerkhera to 16·0 in Jalgaon with intermediary values in other stations. Also the year to year variation at a station is quite appreciable.

The variation in protein content is *not* accounted for by neither the variation in the yield of grain nor the variation in the grain to straw ratio. It is very interesting to find that heavier the seeds less the protein percentage, the correlation coefficient between them being −0·792 which is found to be statistically highly significant.

3. The phenomenon of flowering in Cotton at Viramgam in relation to yield and environmental conditions.

P. S. Sreenivasan *and* J. R. Banerjee, Poona.

The period of flower opening is one of the vital phases of the Cotton crop. In the present paper, the phenomenon of flower opening in relation to the time of sowing, interval between the date of sowing and commencement of flowering, and the final yield has been indicated for the Cotton crop grown at Viramgam under Co-ordinated Crop-Weather Scheme from 1950 onwards. Again, the influence of the maximum and minimum temperatures and the humidity during the period of flowering on the occurrence and intensity of the phenomenon of flower opening has been worked out.

Section XI, Physiology.

1. Relationship between Plasma Electrolytes and Normal blood pressure.

J. V. Bhatt, Agra.

65 normal individuals with blood pressure within normal range have been studied. It has been found that there is a higher level of serum sodium in individuals with higher diastolic pressure. As regards systolic blood pressure the relationship is not so very definite. As regards serum potassium levels and systolic and diastolic blood pressures no clear relationship could be established.

2. Suitability of the frog method, using the Indian frog (Rana Tigrina) for the Biological Assay of tincture of digitalis.

A. K. Ghosh, R. K. Srivastava *and* J. N. Tayal, Kanpur.

The relationship between the log of the dose of tincture of digitalis and the effect in terms of probits of the mortalities (per cent) among the Indian frog, Rana tigrina, weighing between 25 to 50 grammes has been found to be linear. Statistical analysis of the data collected from four experiments performed during July and November has not revealed any evidence of non-linearity in the relationship.

The results obtained by applying the B.P. 2 and 2 Quantal response assay on the frog method have been found to be in fair agreement with those obtained by using guineapigs. The fiducial limits of error of potency of the samples (P=0·95) have been found to lie within the limits specified in the British Pharmacopoeia. By using Rana tigrina, potencies of the Standard, sub-standard and abnormal samples of tincture of digitalis have been satisfactorily determined.

The advantage of the frog method over the guineapig or any other method recommended in B.P. for the biological estimation of the potency of tincture of Digitalis is the quickness and simplicity of the technique, while the disadvantage is the restricted availability of the suitable size of the frog during five months of the year (July to November) only. It has been recommended that the frog method should be given further trial and further data collected in regard to the behaviours of Rana tigrina available in other localities in the country.

3. Microbiological assay of tetracycline hydrochloride.

M. C. MATHUR *and* J. N. TAYAL (T.D.E. Laboratories, Kanpur).

Agar-diffusion method (Cup-Plate technique) has been tried for the microbiological assay of tetracycline Hydrochloride and parenteral preparation thereof containing procaine Hydrochloride, magnesium chloride and buffered with Ascorbic acid. Combinations of S. Aureus and S. Albus with Bond's modified medium for penicillin, V. H. Lee's modified medium for streptomycin and B.P. modified medium for Aureomycin (Chlortetracycline) have been tried. Statistical analysis of data has revealed that the range of variability of the diameter of 'Zones of inhibition' is of the lowest order for the combination of S. Aureus with Bond's modified medium for penicillin; this combination has also been found most satisfactory in regard to the clearness and readability of the Zones of inhibition.

Dose-effect relationship has been studied on concentrations of 0·4 mcg., 0·8 mcg., 1·2 mcg., 1·6 mcg. and 2·0 mcg. of Tetracycline Hydrochloride. Analysis of the variance of the data of four experiments has been made according to the statistical method of Burn and Finney and the test for linearity applied by standard statistical method. It has been shown that there is no doubt about the linearity of the relationship between log-dose and diameters of zones of inhibition.

(2 and 2) dose assay has been applied for the microbiological assay of the potency of tetracycline Hydrochloride using doses of 0·4 mcg. and 0·6 mcg.; the standard preparation was crystalline tetracycline Hydrochloride provided by Lederle laboratories division, American Cyanamide Company. It has been found that the potency ratio between the sample and the standard as well as the fiducial limits of error percent (P=0·95) are within the tolerance limits specified in the British Pharmacopoeia. Results on the Biological assay of samples of tetracycline Hydrochloride and the parenteral preparation buffered with ascorbic acid have been tabulated.

4. Estimation of procaine Penicillin G in mixtures with other Penicillin salts and/or Dihydrostreptomycin.

R. NATARAJAN *and* J. N. TAYAL, Kanpur.

The authors have found that the ultraviolet absorption at 290 m.μ. due to procaine penicillin G is not affected by the presence of Sodium/Potassiam penicillin

G (as such or buffered) and/or Dihydrostreptomycin sulphate. The ultraviolet absorption measurement initially recommended by John for the estimation of procaine in procaine penicillin G, therefore, provides a satisfactory method for the estimation of procaine in mixtures of Procaine Penicillin G with other salts and/or Dihydrostreptomycin. The ultraviolet method is simpler than the colourimetric method described in USP XV.

USP XV has recommended that contents of Procaine Penicillin G and Sodium/Potassium Penicillin G in mixtures of penicillins should be estimated by determining Procaine content colourimetrically and total penicillins iodimetrically; the procaine content which is expected to give an estimate of the procaine penicillin G in the mixture, when subtracted from the total penicillin content gives an estimate of Penicillin G Sodium/Potassium content. It has, however, been shown by the authors that in deteriorated samples of procaine penicillin G, the procaine content does not bear a direct relationship to the penicillin content. Consequently the USP method of separately determining the Procaine Penicillin and Penicillin Sodium/Potassium contents is likely to give erroneous results. It has, therefore, been recommended that chemical assay of such mixtures should consist of determining (a) procaine content by the ultraviolet method and (b) total penicillins by the iodimetric method.

5. Colourimetric estimation of dihydro streptomycin and streptomycin.

R. NATARAJAN *and* J. N. TAYAL, Kanpur.

A modification of the colourimetric method Buchetal, has been described. According to the authors this is a definite improvement over the original method with regard to technique. The method consists in developing a colour with alpha-naphthal and Sodium Hypobromite in an alkaline medium and measuring the transmission per cent of the colour at 530 m.μ. in a Junior Coleman Spectrophotometer at 30 degree centigrade. The values of percentage transmission follow Beer's Law upto a range of 1·5 mg. of Dihydrostreptomycine and streptomycine sulphate.

The proposed colourimetric method which is quick and simple gives values, which compare very favourably with the results obtained by employing standard microbiological method of assay. As the colour reaction is equally applicable to streptomycine and dihydrostreptomycin samples of the latter should be estimated by employing the colourimetric method in conjunction with the B.P. limit test for 'streptomycin'.

6. Colourimetric estimation of Vitamin 'D'.

P. N. LUTHRA *and* J. N. TAYAL, Kanpur.

A colourimetric method suitably modifying Dewitt and Sullivans' method for the estimation of Vitamin D in regard to (a) concentration of Acetyl Chloride in the reagent and (b) solvent has been described. The concentration of Acetyl Chloride is kept at 2·5 to 3·0 ml. per 100 ml. of the reagent. The optical density of the pink colour developed with the reagent is measured at 500 mμ in a Junior Coleman Spectrophotometer provided with 1 cm. tubes. The experiments are performed at room temperature (30 degrees centigrade) in diffused light taking the readings at definite time interval and running a standard preparation simultaneously with the test substance. Interfering sterols, though slightly interfering with the colour of the reaction do not significantly affect the values of Vitamin 'D'.

The proposed colourimetric method is considered suitable for the estimation of Vitamin D content of pharmaceutical preparations, viz., oily solution of calciferol, tablets of calciferol and colloidal preparation of calcium with Vitamin D.

7. The Two Phases of Salivary Secretion.

J. S. Saksena *and* S. Narayan, Bangalore.

Ten minute samples of mixed saliva were collected at half hourly intervals from healthy medical students of both sexes in the age groups 18-22, while fasting and after a varied test feed. In addition to the pH. and volume, the time required for digestion of 4 c.c. of 1% starch solution to Erythrodextrin, and then to simpler products giving no colour with Iodine was determined, using 0·5 c.c. of each salivary sample. This was repeated with another portion of the same starch solution to which 0·9% Sodium Chloride had been added.

It was found that the accelerating effect of added Chloride on amylase activity of saliva disappeared in the first few samples after test feed which is clearly due to the Chloride content of saliva increasing to a level where further addition of Chloride ions is of no advantage. As the effect reappeared and became marked in the later samples, it is logical to conclude that the Chloride content of saliva was markedly reduced in these samples.

Also it was observed that Chloride ions have greater quickening effect on the later stages of salivary digestion of starch than on the earlier ones upto Erythrodextrin formation.

To explain all the observed facts satisfactorily it is proposed that the salivary secretion occurs in two phases.

(1) Buccal or nervous phase—This is reflex in origin, and the quantity and quality of saliva in this phase of secretion depend on the physical state and taste of the food. There is no marked rise in pH. and the Chloride content increases with the rate of secretion.

(2) Gastric or Humoral phase—A more prolonged phase in which the salivary composition is conditioned by gastric secretion. The pH. tends to rise and the Chloride content falls. These are compensatory changes for the loss of H^+ and Cl' ions in the stomach. The saliva secreted in this phase can be a fair index of gastric secretion.

The two phases overlap to a variable degree.

8. Percentage of Carbon-di-oxide in "Alveolar Air" amongst Indians.

J. S. Saksena, Bangalore.

In a series of observations made on self and human volunteers—medical students and members of the staff, it was found that the percentage of carbon-di-oxide in alveolar-air amongst Indians is lower than the figures reported by British and American workers. The figures in 96 volunteers are given which range from 4·86% to 5·36%, with an average of 5·16%.

Prof. Mathur's method was used in collecting the alveolar air samples which were analysed by the Haldane's air analysis Apparatus.

A probable cause for the lower figures in Indians is suggested and the further line of work is indicated.

9. Total daily urinary output on Wheat and Rice Diets in adult human subjects.

N. P. Benawri *and* K. S. Sharma, Gwalior.

Wilson & Mukherji (1935) while experimenting on a human subject observed marked increase of daily urinary output on rice diet (2921 ml.), as compared to wheat diet (1575 ml.). In the present studies daily urinary output was observed in

14 adult males (medical students) who were alternately put on diets otherwise alike but differing in the cereal which was rice in one period and wheat in the other. In some cases rice was given first and wheat later and in others the order was reversed. In some the second period was followed by a third experimental period with the same cereal in the diet as in the first period.

The mean average daily output of urine in all the 14 cases during wheat period was 1341 ml., while on rice diet it was 1798 ml. Our results are thus in general conformity with those of Wilson & Mukherji, though the difference is a little less marked because in this series each diet period lasted a week while in their study it lasted only three days and it was observed that the diuretic effect on rice diet is most marked during the first three days. Average daily Chloride excretion in our series was 19·276 gm. on rice diet as compared to 12·282 gm. on wheat diet. Average daily intake of fluids was also more (93 oz.) on rice diet than on wheat (87 oz.). This observation may be of significance with regard to the observation that urinary calculi are more common among wheat eaters than among rice eaters.

10. Urinary output of Phosphates, Oxalates and Calcium on rice and wheat diets in human subjects.

N. P. BENAWRI *and* K. S. SHARMA, Gwalior.

Studies on excretion of Phosphates, Oxalates and Calcium in the urine were carried out on 14 adult males (medical students) who were alternately put on diets otherwise alike but differing in the cereal which was rice in one period and wheat in the other. In some cases rice was given first and wheat later and in others the order was reversed. In some the second period was followed by a third experimental period with the same cereal in the diet as in the first period.

The figures for daily average excretions are given below :—

(For the entire series)

	Wheat	Rice	per cent difference.
Total (mgms.)	813·69	748·58	8 p.c. less on rice.
PHOSPHATES—			
per 100 ml. (mgm.)	64·89	46·11	28 p.c. less on rice.
Total (mgms.)	60·23	56·01	7 p.c. less on rice.
OXALATES—			
per 100 ml. (mgm.)	4·78	3·31	30 p.c. less on rice.
Total (mgms.)	169·99	196·43	15 p.c. more on rice.
CALCIUM—			
per 100 ml. (mgm.)	13·08	11·61	11 p.c. less on rice.

From the above table it would be clear that in the case of Phosphates and Oxalates the total daily excretion as also the per cent concentration in the urine is significantly less on rice than on wheat diet. In the case of Calcium though the total daily output is more yet the per cent concentration in the urine is less on rice than on wheat diet. These facts, it is suggested, may be responsible, at least partly, for the greater incidence of urinary calculi among wheat eaters than among rice eating people.

11. Uric acid excretion in the urine on rice and wheat diets in human subjects.

N. P. BENAWRI *and* K. S. SHARMA, Gwalior.

Studies on excretion of Uric Acid in the urine were carried out on 14 adult males (medical students) who were alternately put on diets otherwise alike but differing in the cereal which was rice in one period and wheat in the other. In some cases rice was given first and wheat later and in others the order was reversed. Each diet period was of one week. In some the second period was followed by a third experimental period with the same cereal as in the diet of the first period.

The average daily output of Uric acid (all 14 cases) was 602·67 mgms. on rice diet and only 486·21 mgms. on wheat diet. Considering the cases individually 12 out of 14 cases showed a remarkably more total excretion on rice diet than on wheat. The average per cent concentration in mgms. per 100 ml. was, however, slightly more on wheat diet in 50 p.c. cases and slightly more on rice diet in the other half of cases.

The increased total Uric Acid output on apparently well nourished middle class medical students on rice diet as compared to wheat diet is extremely interesting. Further studies with a view to elucidate its possible cause are in progress.

12. Seasonal changes in the histology of the thyroid, the testes and the adrenal cortex of rams.

D. P. MUKHERJEE, B. C. JOSHI *and* P. BHATTACHARYA, Izatnagar.

The thyroid, the testes and the adrenal cortex of 32 adult rams slaughtered at four different seasons viz., summer, autumn, winter and spring were studied. The methods applied and the histological structures of the glands studied were the same as reported for goats. The study revealed that the trend of seasonal variation in the histology of the glands was almost the same as was observed in goats. It was the fluctuation in air temperature which caused the variation in the thyroid and the testes.

13. Some observations on the respiratory reflex in the heat regulating mechanism of dogs.

M. S. CHAUDHURY, Gwalior.

Mathur and Chaudhary (1952) reported that when anaesthetized dogs were heated the opening of the mouth increased the rate of respiration when the rectal temperature has reached near about 41·5°C.

Further observation have led to the conclusion that the temperature at which this reflex mechanism comes into operation depends on the depth of anaesthesia.

The dogs were heated under amytal anaesthesia (75 mgm./kilogm. body weight). The reflex was established. A further dose of anaesthesia (10 mgm./kilogm. body weight) abolished the reflex. On further heating the reflex reappeared at a higher temperature.

Heating the dogs tied on their abdomen with head hanging free on one edge of the table showed that when the critical temperature was reached mouth opened by itself and rate of respiration increased.

It is suggested that it is this reflex which causes panting in unaesthelized dogs during summers for heat loss. It may be operating when rectal temperature goes just a little above the normal.

Section XII, Psychology & Educational Sciences.

1. Psychological Techniques in Motivation Research.

K. MADAN.

Marketing involves the study of the relationship between production and consumption. If the transaction of articles from the producer to the consumer is to be satisfactory it is important to understand the buyer or individual. The attitudes, behaviour and reasons for buying is popularly known as Motivation research.

The application of psychological techniques to commercial problems is still in an experimental stage. Nevertheless, such techniques as group discussions, projective tests, depth interviews, behaviour sampling, etc. can provide information about the consumer, the product or the advertisement theme as the case may be.

Six pictures were devised to ascertain housewives' reactions to a product. Hypotheses were formulated aggression or acceptance to the product depending on the town and class of respondent to be tested. In each town the pictures were shown to 280 respondents matched for age, sex, language and class.

The results of the test suggest that psychological techniques in motivation research can contribute to better scientific marketing.

2. Speed in Decision Taking Under Single Channel Display Conditions.

W. T. V. ADISESHIAH, New Delhi.

This paper describes the findings of recent experiments on Indian Air Force Pilots in test situations involving progressively decreasing time intervals, within which decisions regarding the flight plan were required. The test arrangement, consisting of a single channel display was presented to pupil pilots, flying instructors and jet fighter pilots. It was found that breakdown in accuracy occurred when the required number of decisions exceeded six per minute. Experience in flying jet aircraft does, however, appear to increase the aircraft pilot's tolerance to speed stress.

3. Instrument Design and Pilot Error.

W. T. V. ADISESHIAH *and* M. S. PRAKASH RAO, New Delhi.

In 1955, a large scale study was carried out on pilots of the Indian Air Force, regarding the effectiveness of a modified design of the three pointer altimeter. It was found that the modified design was interpreted with 30% greater speed and accuracy as compared with the conventional design. Analysis of variance showed that the difference was significant at the 0·1% level.

4. The Role of Interests in Memorization and Recall of Picture Material.

M. S. PRAKASH RAO, New Delhi.

In the experimental study reported here, picture material covering different fields of interest was presented to two groups of subjects—Naval Ratings and Civilian Personnel—and their memorized responses were recorded. Analysis has shown that these two groups differed in the preferences shown to different items in the test, giving an indication of their professional interests. The characteristic types of responses made respectively by Naval ratings and Civilian scientists are discussed in the paper.

5. Techniques of student guidance in secondary schools.

S. P. GHOSH, Delhi.

The author in this paper has presented a procedure for Educational and Vocational guidance in secondary Schools and has made an attempt to evaluate them. Of the three types of Guidance—Personal, Educational and Vocational—he is of the opinion that only Education and Vocational guidance can come under the jurisdiction of teacher counsellers. The problem of Personal guidance may be dealt with by the psychiatrists and psycho-analysts.

His procedure includes two parts. The first part includes the tests for measuring general intelligence, practical ability, special aptitudes, personality traits and interests of the candidate. The second part makes an assessment of School achievements, family background, and physical conditions of the candidate as obtained from School records, health report and interview.

The author, in the last, has discussed the procedure of evaluation of the data thus obtained, and has given suggestion for guidance. The procedure is not something fool-proof, but only a provisional one which can be modified in course of further work.

6. A Study of Birth Rituals in an Indian Community.

SHIVKUMARI CHATTERJEE *and* JYOTIRMOY CHATTERJEE, Calcutta.

It is a matter of common observation that numerous types of rituals are associated with birth of the baby. Such rituals differ from place to place and from people to people. A study of such rituals might be expected to be a substantial guide to approach into the depth of racial psychology, as much as it might yield materials for anthropological study. The present study in its own limited way tried to probe into certain birth rituals prevalent in certain north Indian community. The particular rituals studied, as also the other rituals of the community seem to be relatively unspoilt, because University education in this community is relatively less, compared to the other communities in India. Particularly the women in this community never are exposed to outside cultural influence; they never go to school; strict purdah is observed and they even do not expose themselves to male doctors. The study has been done with a comparatively small sample, of materials which one of the authors had the privilege to work. In a number of these families, she conducted number of delivery cases. Partly from her personal observation and partly from a questionnaire specially prepared for this purpose this study was made.

MATERIALS AND METHODS

As already indicated, the study has been done through a specially made questionnaire, which was on the following points : (1) Surname, (2) Original inhabitants of (3) Caste, (4) Size of the family living together, (5) Whether these rites are universal in their community, (6) Short description of these rites—(*a*) during antinatal period, (*b*) at the time of the birth of the baby, (*c*) after birth—rituals done to mother, done to baby, done by mother, done by other members of the family. (7) A schematic drawing showing the position of the mother, the baby and these rituals were done. (8) The meaning of these rituals according to the persons performing them.

On the basis of these eight points the study was made, then scored and tabulated separately. To give a typical example :

Surname—Agarwala.
Original inhabitants of—Ajimgar district.
Caste—Bania.

Size of the family—Husband, Mother of the husband, Two wives, First wife has 4 girls and 3 boys, Second wife has 1 boy and 2 girls.

Short description of the rites—On the nine month of pregnancy the rites begin. Sweets, clothes and money are distributed to poorer people and also presents are given to the prospective mother. When the labour pain starts money in the following order is sent for the purpose of worship. (1) 2 annas for Kaliji. (2) 2 annas for cow. (3) 4 annas for Pat ka Thakurji, i.e. grandfather's portrait in the wall. For quick delivery, raw rice, grass and turmeric is placed in front of the prospective mother, who devide this into two portions. It is expected that such separation would help the separation of the baby from the mother. When the baby is born the midwife should pronounce that a girl has been born even if a boy is born. After the birth of the baby, the elder woman of the family takes some water in her mouth and spits it out on the body of the baby, so that no evil spirit can touch the baby. It is also the custom that the father of the child must see the baby with its cord intact.

RESULTS AND DISCUSSION

Frazer gives numerous descriptions of the homeopathic action done by the primitive man to achieve his end. Raw rice, grass and turmeric, separated into two halves is such a homeopathic or imitative action, by which it is expected that the mother and the baby will be separated. The custom that the midwife should pronounce that a girl has been born might be done partly because formerly in the warrior community a male child was so many times killed by the rivals, also possibly because some of the ill wishing neighbours could exercise their evil charm on the boy, so the birth of a girl was announced. The elder of the family taking some water into her mouth and spitting on the baby is for the purpose of protecting it from evil eye. Evil eyed people like the witches, as was known to the primitive people, could eat up an individual's vitality. But if the would-be victim would have lost sanctity and purity, then even the witch would not touch it. Spitting on the baby is done for this reason.

In the present study it was noticed that though unspoilt relatively and having relatively less communication with the outside world, this community was far from being a closed community, so the significance which these rituals once had in their life is relatively spoilt. To get the unspoilt picture of the ritual and its significance, studies must be done on a larger sample and work is proceeding along this direction.

Section XIII, Engineering & Metallurgy.

Weathering Studies on House Paints.

G. W. KAPSE *and* N. K. PATWARDHAN, Roorkee.

Accelerated tests to evaluate the performance of paints are receiving increased attention. In India, it is observed that paints mostly fail due to chalking, colour fadation and loss of gloss. It was thought possible to correlate these failures both from the natural and accelerated exposure tests.

The present paper deals with 7 House Paints in 3 blue and 4 green shades. 7" × 6" Panels (16 BG mild steel) were exposed outdoor, facing South and inclined at an angle of 45°. Monthly observations in respect of colour, gloss, chalking, checking, cracking etc. were made.

The same paints were tested in a twin arc Atlas Weatherometer using various cycles and various conditions. The 102-18 and 17-3 cycles at 65°C were found to be effective in general. The 17-3 cycle was found to be more effective. The weathering studies are still in progress.

The results obtained so far indicate that a correlation between the natural and accelerated weathering is possible. For the oxford and azure blue paints the correlation with outdoor exposure in respect of chalking and loss of gloss works out to about 1 : 14 and 1 : 22 respectively. Similarly in the case of grass green paint the accelerations in respect of colour and gloss work out to 1 : 18 and 1 : 25 respectively. For Brilliant green in respect of colour fadation it works out to 1 :42.

DISCUSSION

I. THEORY OF CURRENTS

Section of Mathematics

Chairman : PROF. K. CHANDRASEKHARAN, Bombay.

1. B. V. SINGBAL (Bombay) : *Forms, Currents and Cohomology of real manifolds.*

Let M be an n-dimensional C^{∞} manifold countable at infinity; $E^p(M)$ be the vector space of C^{∞} forms of the manifold and $D^p(M)$ be the subspace of $E^p(M)$ consisting of forms with compact support.

In a coordinate neighbourhood of M a form can be written as $\omega^p = \Sigma a_{i_1 \ldots i_p} dx^{i_1} \ldots dx^{i_p}$, $dx^{i_1} . dx^{i_2} = -dx^{i_2} . dx^{i_1}$. On $E = \Sigma E^p(M)$ an exterior differential *d* can be defined which in a coordinate neighbourhood takes the form $d\omega^p = \Sigma d(a_{i_1 \ldots i_p}) dx^{i_1} \ldots dx^{i_p}$ giving rise to a sequence $\rightarrow \ldots E^p(M) \xrightarrow{d_p} E^{p+1}(M) \xrightarrow{d_{p+1}} E^{p+2}(M) \rightarrow \ldots$ such that $d_p d_{p+1} = o$ and a similar one for D's. Groups $H^{p(E)}_{(D)} = \frac{\text{Res. } d_{p+1}}{\text{im } d_p}$ are called de Rham cohomology groups of differential form (with compact support, res *p*).

For a compact manifold by methods of triangulation De Rham proved in 1932 that the above groups are naturally isomorphic to simplicial cohomology groups of M over reals.

M^n is called a Riemann manifold if the tangent space T_m (and hence $\wedge^p T^*_m$ is provided with an inner product written in a coordinate system as $(u, v)_m = \Sigma u_i v_j \left(\frac{\delta}{\delta x_i}, \frac{\delta}{\delta x_j}\right)_m = \Sigma u_i v_j \; g_{ij}(m) = \Sigma g_{ij}(m) \; dx_i \; dx_j$ (symbolically) $g_{ij}(m)$ being C^{∞} functions.

In this case a few more operators are defined on $E^p(M)$ $D^p(M)$.

(1) $^*\omega^p$ defined by $\alpha^p \wedge (^*\omega^p) = (\alpha^p \; \omega^p)$ for every α^p

(2) $\delta = - {}^*d^*$

(3) $\Delta = d\delta + \delta d$. This latter in the case of Euclidean spaces with usual metric is the usual Laplace operator $\Sigma \frac{\delta^2}{\delta x_i{}^2}$ and hence p-forms ω^p such that $\Delta \omega^p = o$ are called harmonic p-forms.

In 1935, for compact M^n Hodge proved that in each cohomology class of forms there exists one and only one harmonic p-form.

Forms and chains however remained till now quite different entities, without any precise relationship between the two. The notion of *currents* introduced by De Rham allows us to put these two together in the same class. A current of degree $p . T^p$ is a linear function on the space D^{n-p} with the following continuity property : If ω^{n-p}_k, $k = 1, 2 \ldots$ tends to zero together with its derivatives all vanishing outside a fixed compact set then $T\,(\omega_k^{n-p}) \to o$. A form ω^p defines a p-current by the formula

$$\omega^p[\Psi^{n-p}] = \int_M \omega^p \wedge \Psi^{n-p}$$

and a p-chain also defines an n-p current, by the formula

$$c^p\,[\Psi^p] = \int_{c^p} \Psi^p$$

All the operators defined on forms naturally extend to the space of currents giving rise to cohomology groups of currents. De Rham's theorems can be stated in the following fashion.

(1) In each cohomology class of currents there exists a closed form and also a cycle.

(2) If a form (resp. cycle) is bounded by a current then it is bounded by a form (resp. chain).

We have also Poincare's duality theorem.

(3) The pth cohomology space of forms with compact support is the topological dual of suitably topological (n-p)th cohomology space of forms with arbitrary support.

Hodge's theorem also follow from the following two theorems

(1) Every square summable current T can be decomposed as $T = H_1T + H_2T + H_3T$, where $H_1T = dS_1$, $H_2T = \delta\, S_2$, H_3T is harmonic.

(2) $\triangle$ is elliptic i.e. $\triangle T = o$ implies T is C^∞

H_3T is then the harmonic form in the cohomology class of T; there is no uniqueness however in the case of non-compact manifolds.

The topological invariance of these De Rham cohomology groups is proved nowadays by using the Theory of Sheaves. We obtain a sheaf A from differential forms (resp. currents) from a presheaf given by $E^p(u)$ $(D'^p(u)$ consisting of forms (resp. currents) defined on open sets $u \subset M$ and with homomorphisms $\rho_{vu} : E^p(u) \to E^p(V)$, $v \subset u$ given by restrictions, the stalks of sheaf $B^p x$ being then dir lim $x \epsilon u$ $\{E^p(u)\}$. These sheaves turn out to be "fine" and by Poincare's theorem the sequence $o \to R \to B^0{}_x \to A^1{}_x \to \ldots \to A^p{}_x \to A^{p+1}{}_x \to \ldots$ is exact, so that A^p becomes a "resolution" of R and the uniqueness theorem in the theory of sheaves states that for any two resolutions of R the groups $H\ (\Gamma(x, \pi))$ are naturally isomorphic, and since $H\ (\Gamma(x, A))$ are precisely the homology groups of De Rham, taking other resolution to be one given by singular cochains or Alexander cochains we have the invariance theorem.

Recently a number of applications have been made of the theory of sheaves and the theory of currents, which will be dealt with in following lectures.

Firstly, since holomorphic forms on complex analytic manifolds and local rings on algebraic varieties form again good pre-sheaves, sheaf-theoretical methods give topological information with help of analytic or algebraic structure such as determination of homology by using holomorphic forms, Serre's duality theorem, generalizing Poincare duality theorem Riemann-Roch Theorems in certain cases, a homological characterization of Stein manifolds in the class of complex manifolds, etc. and vice versa.

Secondly the possibility of defining currents attached to different singularities allows us to give generalized solutions of existence problems such as solving Cousin's problems, defining meromorphic functions associated with divisors on algebraic and Kähler manifolds, which generalized solutions under suitable restrictions become the usual ones.

Thirdly, if the manifold possesses a group structure in addition, so that M becomes now a Lie group, E. Cartan proved for compact M that De Rham cohomology spaces are isomorphic to space of "invariant forms", these being precisely harmonic forms in an invariant metric that can be introduced on the group; and Chevally, Eilenberg further proved that they are isomorphic to cohomology space of Lie algebra associated with the group. The algebraic topological study of Lie groups becomes then algebraic study of the associated Lie algebra.

2. C. RACINE (Madras) : *Cohomology of Lie Groups and of Lie Algebras.*

The study of Lie Groups from a "global" point of view began only around 1925 with the pioneer work of E. Cartan and H. Weyl. Until fifteen years ago, its progress remained slow owing to an insufficient development of Topology, Algebra and Algebraic Topology. The outstanding results, during this period, are those of E. Cartan and G. de Rham on the Betti numbers of compact, simple, groups, the theorem of complete reducibility of H. Weyl and the proof of the converse of Lie's third theorem by E. Cartan, made possible by his own results on the Betti numbers of compact groups.

For the last fifteen years, great strides have been made in Algebraic Topology and, as a consequence, the Topology of Lie Groups has become a vast and important field of research of modern Mathematics. It is the purpose of this talk to survey some of the outstanding results which have widened it recently.

The advance to be considered is one which, to a greater extent than many others, has been inspired by the work of E. Cartan on Lie Algebras and Differential Forms. It is based on a method which reduces questions about Lie groups to questions about invariant differential forms on their manifolds and questions about these differential forms to questions about Lie Algebras. This remarkable method was proposed in 1948 by C. Chevalley and S. Eilenberg. It was immediately applied and extended by J. L. Koszul in 1950 and led, in particular, to a new and deep interpretation of Hopf's "primitive" elements as well as to a simpler proof and an extension of Hopf's main theorem. This interpretation, however, did not make full use of the notion of transgression; it was improved and made deeper by the subsequent work of A. Weil, C. Chevalley and H. Cartan, basing the transgression theorems on the theory of Weil's algebras.

Koszul has also made use of his method and of Leray's theory of "special sequences" to study the relative cohomology of Lie Algebras.

3. M. S. NARASIMHAN (Bombay) : *Cohomology of complex analytic manifolds.*

Let M be a complex analytic manifold of complex dimension n, which is countable at infinity. The operator d of exterior differentiation (on C^∞ forms and currents) splits into two operators d_z and $d_{\bar z}$: $d = d_z + d_{\bar z}$, where d_z is the derivation with respect to the z variables and $d_{\bar z}$ is the derivation with respect to the $\bar z$ variables. We have $d^2_z = d^2_{\bar z} = 0$.

Let V be a complex analytic vector bundle on M (with fibre G_r and Group $GL_r(G)$)). We denote by $\Omega^p(V)$ the sheaf of germs of holomorphic p-forms on M with coefficients in V. Let Φ be a family of "supports" and let $H^q_\Phi(M, \Omega^p(V))$ denote the qth cohomology vector space (over G) of M with coefficients in the sheaf $\Omega^p(V)$ and supports in the family Φ. Let $A^{p,q}(V)$ be space of C^∞ differential forms of bidegree (p, q) with coefficients in V and $A^{p,q}_\Phi(V)$ the subspace of $A^{p,q}(V)$ consisting of those elements whose supports belong to the family Φ. The operator $d_{\bar z} : A^{p,q}_{\Phi}(V) \longrightarrow A^{p,q+1}_{\Phi}(V)$ can be defined and $A_{\Phi}(V) = \sum_{p,q} A^{p,q}_{\Phi}(V)$ is a bigraded complex with the differential operator $d_{\bar z}$; we denote its cohomology space of bidegree (p, q) by $H_{\bar z}^{p,q}(A_{\Phi}(V))$. Let $K_{\Phi}^{p,q}(V)$, $K_{\Phi}(V)$ and $H_{\bar z}^{p,q}(K_{\Phi}(V))$ denote the corresponding spaces when forms are replaced by currents. A theorem of Grothendieck and a theorem from sheaf theory give immediately the *Theorem of Dolbeault—Serre*: The vector space $H_{\Phi}^{q}(M, \Omega^{p}(V))$ is canonically isomorphic to $H_{\bar z}^{p,q}A_{\Phi}(V))$ and also to $H_{\bar z}^{p,q}(K_{\Phi}(V))$.

The space $A^{p,q}(V)$ endowed with the topology of "local uniform convergence of each derivative" becomes a Fréchet space (analogous to the space E of Schwartz). The topological dual of $A^{p,q}(V)$ is naturally isomorphic with $K_{(*)}^{n-p,n-q}(V^*)$ where V^* is the dual vector bundle of V and (*) denotes the family of all compact sets of M. The transpose of $d_{\bar z}$ by this duality is d_z (upto a sign). A lemma on topological vector spaces together with the Dolbeaut-Serre theorem then yields

Serre's duality theorem: If the two linear maps

$$A^{p,q-1}(V) \xrightarrow{d_z} A^{p,q}(V) \xrightarrow{d_{\bar z}} A^{p,q+1}(V)$$

are homomorphisms, the topological dual of the Fréchet space $H^{q}(M, \Omega^{p}(V))$ is canonically isomorphic to $H^{n-q}_{(*)}(M, \Omega^{n-p}(V^*))$. [$H^{q}(M, \Omega^{p}(V) = H_{\Phi'}^{q}(M, \Omega^{p}(V))$ where Φ' is the family of all closed sets of M].

$d_{\bar z} : A^{p,q}(V) \longrightarrow A^{p,q+1}(V)$ is not always a homomorphism. However if M is compact or is a Stein manifold d_z is a homomorphism. The duality theorem has applications to Stein manifolds and divisors on compact manifolds and also yields an elegant proof of the Riemann-Roch theorem on a compact Riemann surface.

4. C. S. SESHADRI: *Construction of a multiplicative meromorphic function on a compact Kählerian manifold.*

Let X be a compact Kählerian manifold, (i.e.) a compact complex analytic manifold with a Hermitian structure such that the imaginary part of the associated Hermitian form is closed. Let G denote the sheaf of germs of meromorphic functions on X and F the sheaf of germs of non-vanishing holomorphic functions. D is the quotient sheaf G/F. A section *D* of D on X is said to be a divisor. To every divisor there corresponds a uniquely determined element of the second integral cohomology group of X. The divisor is said to be of "degree zero" if this element of the second integral cohomology group is zero considered as an element of the corresponding real cohomology group.

A multi-valued meromorphic function on X is said to be a ***multiplicative meromorphic function*** if its modulus is single-valued. A multiplicative meromorphic function defines uniquely a divisor D. The problem is to characterise divisors which are divisors of multiplicative meromorphic functions. A theorem of A. Weil asserts that a divisor D is the divisor of a multiplicative meromorphic function if and only if it is of "degree zero".

II. QUADRATIC FORMS AND MODULAR FUNCTIONS

Chairman: PROF. K. CHANDRASEKHARAN, Bombay.

1. K. G. RAMANATHAN (Bombay): *The arithmetic theory of quadratic forms.*

The arithmetic theory of quadratic forms originated with the work of Gauss and Lagrange who studied systematically the case of binary forms. Later Legendre,

Eisenstein and Smith extended this to the case of ternary forms. The modern theory of quadratic forms in any number of variables started with the papers of Hermite and Minkowski. During the past 3 decades, Siegel not only solved all the outstanding problems raised by the work of Gauss, Hermite and Minkowski but also initiated the study of quadratic forms with elements in involutorial division algebras of finite rank over the field of rational numbers. Our object is to review the work of Gauss, Hermite, Minkowski and Siegel with special reference to involutorial algebras.

2. S. RAGHAVAN : *Theta series of definite quadratic forms.*

In the problem of finding an asymptotic formula for R (n), the number of representations of a positive integer n as a sum of m squares, or more generally, by a positive definite quadratic form $X' S X = \sum_{i,j} s_{ij} x_i x_j$ with integral coefficients s_{ij} in the m variables $x_1, \ldots, x_m$, one considers the generating function

$$f(z) = \sum_{X} e^{2\pi i X' S X z} \quad \text{(summation over all integral vectors } X = \begin{pmatrix} x_1 \\ \vdots \\ x_m \end{pmatrix}\text{)}$$

$$= 1 + \sum_{n=1}^{\infty} R(n)\, e^{2\pi i n z} \qquad (z = x + iy \text{ is a complex variable with } y > 0)$$

which is a so called ϑ-series. When m is even, f(z) is found to be an entire modular form of dimension $-\frac{m}{2}$ and stufe $2^{m+1} \mid S \mid$ (where $\mid S \mid$ is the determinant of the form X′ S X). Hecks found for the coefficients of an entire cuspform $\sum_{n=1}^{\infty} c_n e^{\frac{2\pi i n z}{N}}$ of integral dimension $-k$ $(k \geqslant 1)$ and stufe N, an estimate $c_n = 0\ (n^{k/2})$. If one constructs another entire modular form (called an Eisenstein series) $g(z) = \sum_{n=0}^{\infty} b_n e^{\frac{2\pi i n z}{N}}$ of the same dimension and same stufe and having the same behaviour as f(z) at all cusps of the fundamental domain, in the upper z half-plane, of the principal congruence subgroup Γ (N) of stufe N, then $f(z) - g(z) = \sum_{n=1}^{\infty} c_n e^{\frac{2\pi i n z}{N}}$ is a cusp form and one gets, by applying the estimate of Hecke, in the case when m is even and greater than four, the formula

$$R(n) = b_n + 0\ (n^{k/4}) \text{ where } n^{1-k} b_n \text{ is the "singular series".}$$

Hecke's estimate is not sharp enough for $m = 4$. Kloosterman improved it to $c_n = 0\ (n^{7/8 + \varepsilon})$ $(\varepsilon > 0)$ for coefficients of a cusp form $\sum_{n=1}^{\infty} c_n e^{\frac{2\pi i n z}{N}}$ of dimension -2 and stufe N.

When m is odd and greater than three, the ϑ-series f(z) is an entire modular form of dimension $-\frac{m}{2}$ and stufe $2^{m+1} \mid S \mid$ and belonging to a ϑ-multiplicator group. In this case, one uses Petersson's estimate for coefficients of cusp forms

of real negative dimension. Mention must be made here of Maass' construction of integral modular forms of dimension—3/2 by employing an idea of Hecke and the deduction of the formula for the number of representations of an integer as sum of three squares.

3. V. VENUGOPAL RAO : *Zeta functions of quadratic forms.*

Riemann studied the zeta function $\zeta(s)$ defined by means of the Dirichlet series $\sum_{n=1}^{\infty} \frac{1}{n^s}$ in its half plane of convergence. He showed that $\zeta(s)$ is meromorphic with a single pole at $s=1$ and satisfies the functional equation $\xi(s)=\xi(1-s)$ with $\xi(s)=\pi^{-s/2}\,\Gamma(s/2)\,\zeta(s)$. One of the methods of analytic continuation consists in considering the Mellin transform of the theta function $\vartheta(\tau)=\sum^{\infty} e^{\pi i n^2 \tau}$ $(I(\tau)>0)$ and using the fact that $\vartheta(\tau)$ is a modular form of the subgroup of stufe 2 of the modular group, various generalizations of $\zeta(s)$ have been studied. In particular P. Epstein has considered, for S a real symmetric positive definite matrix with m rows and any two fixed real column vectors A and H with m rows, the function

$$(1)\quad \zeta(S, A, H, s)=\sum_{\substack{x \text{ integral}\\ S[x+A]\neq 0}} \frac{e^{2\pi i x'H}}{\{S[x+A]\}^s}=\sum_{t>0} \frac{A(S, A, H, t)}{t^s}$$

with

$$(2)\quad A(S, A, H, t)=\sum_{\substack{x \text{ integral}\\ S[x+A]=t}} e^{2\pi i x'H}$$

He continued $\zeta(S, A, H, s)$ analytically over the entire complex s plane by using the transformation formula for the generalized theta function associated with S, A, H and obtained a functional equation similar to that of Riemann zeta function. $\zeta(S, A, H, s)$ is meromorphic with a simple pole at $s=\frac{m}{2}$ if and only if H is integral.

For S indefinite the number of summands on the right of (2) is in general infinite and one would have generalized $\zeta(S, A, H, s)$ to indefinite forms as soon as one generalizes the function $A(S, A, H\ t)$ to S indefinite. This has been done by C. L. Siegel who has defined for S, A rational, a function $\mu(S, A, o, t)$ which generalizes $A(S, A, o, t)$ to S indefinite. Further he also studied the properties of the corresponding zeta function for $A=o$, defined by

$$(3)\quad \zeta^*(S, o, o, s)=\sum \frac{\mu(S, o, o, t)}{t^s}$$

In this case it turns out that $\zeta^*(S, o, o, s)$ is meromorphic. The functional equation of $\zeta^*(S, o, o, s)$ is similar to Epstein's if and only if $|S|>0$. The functions which play the role of theta series in the case of Riemann and Epstein are here in general non-analytic functions and they have been studied extensively by H. Maass. It is possible to define $\mu(S, A, H, t)$ for arbitrary H rational and study the corresponding zeta function $\zeta(S, A, H, s)$.

4. S. S. RANGACHARI : *Representation of Modular forms by theta-series.*

In the space of modular forms of a certain type, Hecke introduced a ring of linear operators, which takes the space onto itself. The natural question then is to decompose this space into all invariant subspaces. This has been done only in certain special cases.

The theta-series $\vartheta(\tau, Q)$ associated with even positive quadratic forms Q in an even number of variables (say) 2f, are integral modular forms of dimension -f, and stufe N depending upon Q. The problem then arose whether the space of all theta-series of a certain type is, in every case, an invariant subspace and whether this subspace spans the whole space of modular forms of that type. These questions have not been solved in full generality but only in certain cases, which we shall list below :

If we consider theta-series with weights which are spherical function and homogeneous polynomials of degree ν, $\vartheta(\tau, Q, P_\nu) = \sum_{(n_1 \ldots n_{2f})} P_\nu(n_1 \ldots n_{2f})\, e^{2\pi i \tau Q(n_1, \ldots n_{2f})}$

they are seen to be modular forms of dim $-(f+\nu)$ and stufe N depending upon Q. For $\nu = o$ these are $\vartheta(\tau, Q)$ and for $\nu > o$, they are cusp forms. In the case of Q being binary, these series of a fixed type and fixed ν, form a closed system.

For even quadratic forms with discriminant 1, it can be shown by using Siegel's theory that all modular forms of dimension —41 and stufe 1 are representable linearly by theta-series $\vartheta(\tau, Q)$.

For forms with stufe q, an odd prime, Hecke conjectured (in 1935) that modular forms can be represented by theta-series. It was proved by Eichler in 1955 that all integral modular forms of dimension -2 and stufe q are linear combinations of theta-series associated with norm forms of a definite quaternion algebras. This is achieved by comparing the traces of representations of modular correspondences (which are generalized Hecke operators) in the space of cusp forms and theta-series respectively. He extends this result to dimension $-2k$ in the usual fashion.

We may also consider weighted theta-series in the above case and Eichler has proved that this is a closed system for his ring of modular correspondences.

III. MATHEMATICAL EDUCATION IN INDIAN UNIVERSITIES

Chairman : PROF. K. CHANDRASEKHARAN, Bombay.

1. FR. C. RACINE (Madras) :

The teaching of Sciences and, in particular, of Mathematics has obviously a cultural value which is nowadays on the increase on account of the ever greater importance played by Sciences and Techniques in our modern world. But, precisely because this modern world is organized in such a way that *the sciences and techniques become more and more an essential condition of social life*, the teaching of sciences and of technology must be granted an importance *until now unknown* in the educational organization of a nation.

Although questions about syllabuses are of much less importance than those concerning the selection of a qualified staff, it may not be quite useless to lay stress on a few principles concerning such questions :

(1) The fact that the development of Mathematics for the last 30 years has been one unequalled in the history of Mathematics, save the period following the

introduction of a Calculus and its applications to Celestial Dynamics and Physics, a drastic effort of adaptation is necessary to avoid deadly stagnation.

(2) Yet one must avoid the other extreme: going too fast in initiating the students to a number of branches of modern Mathematics. Up to the M.A. degree, what is essential is to train the mind of the student to *think easily in abstract terms,* to grasp the axiomatic method. What has to be taught is much more *how to learn* than *all what may be learned.* A mathematician will have to read and assimilate personally a lot of theories. He must have been *trained to read and assimilate with intelligence and discipline.* The "pauca sed perfecta" of Hermite (little but in a perfect manner) which he (Hermite) was proposing as an advice to Research people may be taken as the motto of Teaching at any level.

(3) The so called "Applied Mathematics" syllabuses are obviously in need of a most drastic revision. The old fashioned text books still in honour must be discarded. There should be a clear distinction between *"Theoretical Mechanics"* (The "Mecanique Rationnelle" of the French Universities, for instance) and *Applied Mechanics* which needs not be taught at the M.A. level except as an optional subject. Insistence on principles, systematization, and disregard for the endless, silly, problems of the tripos type should be a strict rule.

(4) Calculus is obviously of fundamental importance. But of equal importance is also some initiation to Modern Algebra. This subject is more than any other a right introduction to the axiomatic method. No M.A. student should know less than, for instance, the text of Mary Weiss (for undergraduates in the U.S.A.!) In Calculus it should become obvious that the Riemann integral has become outdated. There should be a good grounding in the theory of integrals of a continuous function, then some introduction to the Lebesgue integral. The outstanding treatment of it by F. Riesz and de Nagy in their recent treatise on Functional Analysis is one which should not be above the level of an M.A. course.

(5) The various courses still unfortunately in honour, about Pure and Analytical Geometry should be left to the care of the Professors of Archaeology. A combined course of Algebraic and Differential Geometry, including the theory of surfaces is quite feasible. (Algebraic Geometry without the theory of ideals of course! But something more or less as what is found in the Analysis of C. Jordan).

2. PROF. K. R. GUNJIKAR (Bombay):

It is necessary to provide a suitable course for students who are not going to specialize in Mathematics and who do not possess mathematical ability of a high order. This should be done during the first year after the ordinary school leaving stage by the university or by the Higher Secondary Board for its certificate. *This should be compulsory* for all those continuing their studies in science, medicine, technology etc. Otherwise the standards in these subjects will suffer greatly.

The subjects taught should be:

Algebra: Indices, logarithms; simple surds, idea of irrational number; graphs of $y=x^n$, for simple rational n and of $y=2^x$, 10^x, a^x for $a>o$. Binomial theorem for positive integral exponent with statement and application to fractional and negative exponents in simple cases. Arithmetical and geometrical progression and means. Harmonic mean. Simple linear permutations and combinations. Quadratic equations. Complex numbers.

Geometry: Similar polygons and ratios of their areas. Angle between two planes and a plane and a line. Tetrahedron and parallelopiped. Trigonometrical ratios and notation with applications and use of tables; sine and cosine of sums of two angles and of related angles.

Calculus: Notion of derivative with differentiation of polynomials and powers of x and a^x from first principles. Introduction of e. Tangents, gradient maxima and minima and simple rate problems.

Definition of area as limit of sum. Area of circle and radian measure. Formation of integrals of area and volume. Differentiation of area under a curve and evaluation by primitives.

The course in Calculus should be kept simple and should make full use of geometrical and physical intuition.

For the mathematically minded students this course should be both broadened and deepened, and should be supplemented with *Analytical geometry* of the conics, solid geometry, mechanics (Kinematics being integrated with calculus), notion of the simplest types of differential equations being included in the calculus syllabus at the Intermediate stage.

At the first degree stage (4 years after school leaving) elements of Modern Algebra, Modern Analysis and vector theory should be included, room being made for these by eliminating some of the sterile parts of Algebra, Geometry and Calculus and lessening the emphasis on abstruse problems.

Similar modernisation at the Master's degree stage is necessary. To improve the nature of the syllabi and to reform the structure of examination papers, it would be desirable to take the help of the Union and State Public Service Commissions which influence the University studies in a great measure.

3. PROF. N. R. SEN (Calcutta) :

There is going to be a reorientation as regards periods of studies in the school and the college all over India in near future. So it is just the time to think of having an integrated school and college course for Mathematics starting from the upper two classes in school. There should be a motivation in the construction of the syllabus even at the school and lower stages of the College. Though early bifurcation for necessary technological studies should be remembered the necessary outlook favouring a possible stage of higher study and research should not be lost sight of.

As regards the general objective of the B.A. and B.Sc. syllabus I am in agreement with the suggestions made in the second paragraph of the abstract of Prof. Racine's intended lecture which has been printed.

The phenomenal progress in mathematical thought and in the physical sciences in the last few decades, as well as the present needs of the country call for proper stress in both pure and applied aspects of mathematics in the University courses. The present idea that "applied mathematics" implies only what has so far been known as Rational Mechanics should be revised. In our higher courses generally phenomena governed by linear differential questions in different fields (not merely Laplace Equation) should be studied but non-linear hydrodynamic field need not be outside the scope.

For research students equipments far beyond those supplied by the Masters' degree course are necessary for which special courses should be organised including spectral theory of operators, Green's functions, partial differential equations, Laplace and Fourier transforms.

A change more important than any change in syllabus is necessary in our Colleges is the way of the method of teaching. A method should be desired in which students should not be expected merely to listen to lectures and take an examination at the end of one or two years, but efforts in the way of working up those lectures under supervision of teachers should be demanded of them. These methods may be different in different Universities.

4. PROF. R. VAIDYANATHSWAMY (Triputi, Andhra) :

(1) Prof. Racine has underestimated the importance of geometrical intuition in Mathematics and the part played by analytical geometry of two and three dimensions. Logic and intuition each has its own place in Mathematics and neither *can be sacrificed to the other.*

(2) University teachers should be equipped with an adequate knowledge of the classical higher mathematical discipline including the following :

(*i*) Invariant theory, tensor-calculus, differential geometry and algebraic geometry.
(*ii*) Measure, integration and functions of a real variable.
(*iii*) Analytic functions, Integral functions and elliptic functions.
(*iv*) Modern Algebra, including some group theory and linear algebra.
(*v*) Topology and function-spaces.
(*vi*) Set-algebra and partially ordered sets.

Whatever may be the label given to a course comprising these subjects, a teacher at the degree level should be expected to know the above subjects. The research institutes in the country should take a lead in the training of teachers for this course.

(3) There has been criticism that our graduates lack initiative and independent thinking. It is clear that our teaching has something to do with this. The system of instruction must be revised. At present our teachers in Colleges and Universities go through the syllabus from A to Z in a uniform scheme of lectures. This method of teaching, like steam-roller, prevents experience of studying the text-book for oneself and of understanding them by oneself. Moreover the teacher talks only to the group-mind of the class and not to the individual mind. Therefore the reform, which is urgent, is to divide the instruction into two parts : (*a*) what the teacher should teach to the student, (*b*) what the student should pick up from the text-books under supervision and occasional guidance of the teacher. For effective tutorial guidance the class should be divided into small groups of four or five students. We are making an analysis of the subjects (*a*) and (*b*) in Sri Venkateswara University College. This scheme should work well for a class of 30 or 35 students. For larger classes different measures are necessary.

5. PROF. A. C. BANERJEE (Jadavpur) :

I suggest that stress should be laid on methods of teaching. Routine lecture notes and standard exercises which may win easy popularity for the teacher should be avoided. The education in Mathematics should have a historical bias and the aid of physical intuition should be invoked, whenever possible.

The ratio of teachers to students at a higher level of teaching should be greater than at lower levels. There should be an exchange of teachers among the various universities.

Referring to a suggestion of Prof. Vaidyanathswamy the Chairman remarked that the training of the kind described above in (2) has been imparted regularly in the Tata Institute of Fundamental Research, Bombay, for the last four years and that this programme will be considerably stepped up from the next year.

Answering a question of Prof. A. C. Banerjee, the Chairman said that a course for M.A. should be for a period not less than two years after the B.A. course whether the latter course runs over four years after the Matriculation examination or three years after higher Secondary examination.

I. RECENT CONTRIBUTION TO STATISTICAL INFERENCE

Section of Statistics

Chairman : Dr. P. K. BOSE (Calcutta)

Prof. J. Neyman (U.S.A.) who opened the discussion dealt with the problem of testing of composite hypothesis and explained his method for asymptotic tests of such hypotheses.

Dr. M. N. Ghosh (Calcutta) : The theory of statistical inference has recently been broadened into the general theory of decision functions, from its earlier systematic formulation by Neyman and Pearson. In this transition the concepts could in some cases be reformulated in analogous terms. Thus Lehmann has introduced the concept of unbiassedness in decision problems. The concept of a composite hypothesis may be introduced in decision problems and results similar to the constructability of tests of such hypotheses from sufficient statistics may be established for the decision problem. A systematic efforts in this direction, *i.e.*, fitting the concepts of Neyman—Pearson's theory to general decision problems, would be fruitful, at present.

Dr. D. Basu (Calcutta) discussed the implications of the existence of a complete sufficient statistics on the problem of estimation and hypothesis testing.

Dr. A. R. Roy (New Delhi) discussed at length some problems associated with X^2 test.

II. ROLE OF STATISTICS IN AGRICULTURE AND BIOLOGY

Section of Statistics with Section of Agriculture

Chairman : Dr. P. K. Bose (Calcutta).

Dr. C. Chandra Sekharan (Calcutta) opened the discussion. He briefly discussed some statistical methods which are useful in Biology and in Agriculture.

Dr. T. S. Narayana (New Delhi) narrated some difficulties of the entomologists. He suggested that ordinary statiscal methods sometimes are not useful in entomology. He asked the statistician to realise the difficulties of entomologists and to help them with new statistical tools.

Dr. A. C. Das (Calcutta) discussed some problems in two stages and systematic sampling.

Shri Shumsher Singh (Kanpur), Dr. K. C. Seal (Calcutta) and Shri N. K. Chakrabarti (Kanpur) also participated in the discussion.

I. MAGNETIC, IONOSPHERIC AND SOLAR PHENOMENA

1. Prof. S. K. MITRA opened the Symposium ss.

Chairman : Prof. K. R. Dixit (Ahmedabad).

Section of Physics

2. S. L. MALURKAR (Bombay) : *Geomagnetic Storms and Progress of Sun Spots.*

There is hardly any doubt that much of the variations in geomagnetic activity at a place is due to sun as a result of radiation and emission of charged and sometimes uncharged particles. The radiation part gets changed during chromospheric eruptions and the latter gets linked up with active regions of the sun and the sun spots.

It is generally assumed that within 24 to 48 hours of the passages of an active sun spot group or region across the sun's central meridian a geomagnetic storm might or would result. During the active period of sun's activity spots cross the central meridian in regular succession and it would be difficult to assign a magnetic storm with the central meridian passage of a particular group. A tabulation of the evolution at central a few days before and a day after the commencement of a magnetic storm at Alibag was made for years published data were easily available. As was to be expected a few of the prominent magnetic storms followed large spots crossing the C.M. But in the case of a larger number of magnetic storms such inter-relation could be had. Some of the really big storms were associated with quite insignificant spots.

[The tables extend over several pages which can be projected].

There is of course no definite evidence that the passage across other meridians of the sun could be associated with magnetic storms, as in the case of solar flares. In a few instances, it appeared that the spots were in a degrading stage.

3. A. K. SAHA (Haringhata) : *Some special features of the ionosphere observed at Haringhata (Calcutta).*

The automatic h′-f records reveal the presence of an E2 layer between the normal E layer and F1 layer in the afternoon. It first appears as a 'ridge' in the F1 layer trace and then moves downward to the normal E layer height, ultimately forming sporadic ionization at this height. E2 layer trace also appears in the early morning traces only in the equinox months.

Night time F-region reflections are often associated with intense IF scatter. Parallel F-layer traces (distinct from multiple echoes) sometimes appear on night time records. IF scatter echoes are found to occur invariably on magnetically disturbed days and only occasionally on some quiet days. No such correlation could be found in the occurrence of F-layer double traces.

Following the recommendations of the URSI, 1954, preparations are being made at Haringhata to delineate routine ionospheric variations in terms of the true heights of the ionospheric layers.

4. R. B. BANERJEE (Calcutta) : *Methods of measuring Ionospheric winds by fading at spaced receivers.*

The study of fading of singly reflected, vertically incident sky waves at three points was initiated by S. N. Mitra and independently by T. Krautkramer. Both methods, in effect, sought to determine the velocity of drift of an irregular diffraction pattern across the ground. In the early stages, however, certain general characteristics of this diffraction pattern were imperfectly understood and later developments have necessitated modifications of the method of analysis. In the present work, all the methods so far developed have been studied in their interrelationships and one of the methods has been generalised to cover a wider range of conditions.

To this end we have initially reviewed the details of the problem and its mathematical formulation. From this the discussion has been led to the methods of analysis suggested by Briggs, Phillips and Shinn and by Yerg.

These authors have used the statistical properties of the fading patterns, differing only in their method of analysis and the parameters considered fundamental. We have then discussed the other method of approach, taken by Mitra, which uses the similarity of fading patterns as the basis of approach. The statistics inherent in the problem, however, was entirely neglected by him as well as by Krautkramer. Two lines of improvement to this method have been suggested, one by Rateliffe and his school, the other by Pütter. These methods, however, are both prone to throw out a large amount of information and are more or less complementary. We have been able in this work to effect a fusion of the two methods. The resulting procedure for wind measurement is then compared to the others.

5. DR. S. S. BARAL (Sibpur, Howrah) : *F2 layer abnormalities.*

The anomalies of the F2 region can be classified as follows : (1) Diurnal and seasonal anomaly, (2) Latitude and longitude anomaly, (3) Solar cycle anomaly and (4) Storm-time anomaly. Studies made after these classifications show that : (1) In general, the anomalies are more pronounced when the single F region is bifurcated into the F1 and F2 regions, (2) multiple values of F2 for the same season and for the same mean sunspot number are linked with the differences in the incidence of magnetic storms in the rising and falling parts of solar activity, (3) the summer-winter difference in the response to solar activity change decreases progressively from high to low latitudes in both the hemispheres. The difference is least near the geographic rather than the geomagnetic equator.

A consideration of the effects of (1) vertical ion transport, (2) horizontal drift, (3) temperature variation and (4) diffusion in the F2 region as causes of the anomalies, has shown that the vertical ion transport plays the most important part in producing the anomalies. Similarity of the morphology of F2 region variations with the morphology of magnetic variations (on both quiet-day and disturbed-days) lends support to this conclusion.

6. J. S. CHATTERJEE (Jadavpur, Bengal) : *Effect of Solar Corpuscular radiation on Terrestrial magnetism.*

Magnetic Storms, which recur at intervals of about 27 days are the result of the encounter of neutral solar corpuscular radiation (equal numbers of positive and negative charges) with the earth magnet. The nature of the magnetic field of a typical world wide magnetic storm is characterised by a quick increase of the field followed by a drop below the steady value within about 10 hours. The field then recovers slowly to the steady value within a few days. It is shown that such magnetic storms may be the cause of the permanent magnetisation of the earth. Two methods by which the magnetisation is caused are discussed.

Firstly, due to high pressure and temperature prevailing in the crust of the earth, a shell 20 km. thick, situated 5 km. below the surface, will behave as a material of high permeability and will be magnetised to saturation by a low field of the order of 0·01 gauss. Starting from a small beginning, the field of successive magnetic storms will bring the magnetisation of the crust to the saturation point. The nature of the magnetisation is such as to explain the magnetic moment of the earth.

Secondly, during storm-time variation of the magnetic field, currents are induced in the body of the earth. These currrents decay after a long time. It is shown that successive magnetic storms have a cumulative effect causing the magnetisation of the core of the earth.

7. A. P. MITRA : *Effect of Solar Flares on the Lower Ionosphere (60-100 Km.) and the associated magnetic effect.*

In this work observations made over a number of years and in many countries on all ionospheric and magnetic disturbances associated with solar flares are examined, and a model of the flare ionization obtained.

The following conclusions are drawn :

(*a*) The Ionospheric effects of a flare are limited within the heights 60-100 Km, the primary effect being an overall enhancement of the entire D-region (and not production of a new region), with the possibility of an additional enhancement *in the lower E. There is a well-defined relationship between the SPA's and the fadeout absorption values. From this relationship it is possible to obtain a model of the normal D-region upto the level of maximum of this region. Such a model has been deduced.*

(*b*) In general the times of maxima for the different phenomena are delayed differently for the same flare conditions. These delay times give a very sensitive indication of the ionospheric levels at which the effects take place and, if the levels are known, give values for the ionization enhancements for different flare conditions. Using this method, we find that, on the average, such enhancements are of the order of 2·5, 4·5 and 8·0 for class 1, class 2 and class 3 flares.

(*c*) It seems probable that both the normal D-ionization and the flare ionization are due to the ionization of NO by L_α radiation. The enhancements in the average photon flux for this radiation are estimated to be 5, 20 and 70 for flares of class 1, class 2 and class 3 respectively.

(*d*) An examination of the delay time of the magnetic effect shows that the current system responsible for it is located around 100 Km.

It has been possible to deduce models of the lower ionosphere for various flare conditions that will quantitatively explain all SID phenomena, including the magnetic effect.

Some curious features of the SID's associated with the solar event of February 23, 1956, are also discussed.

8. Remarks by Dr. K. R. RAMANATHAN.

9. R. V. BHONSLE (Ahmedabad) : *Ionospheric Effects on Cosmic Radio Noise (25 Mc/s.).*

Since May 1956, the Physical Research Laboratory, Ahmedabad has been keeping continuous records of the intensity of cosmic radio noise on 25 Mc/s using a broadside-collinear array of 16 half-waves dipoles and a Hammarlund Communications Receiver. The output is amplified by a D.C. amplifier and fed to an Evershed Recording Milliammeter. The aerial, which is fixed and situated 0·2λ above ground, has a main lobe of about 30° in E-W direction and 37° in N-S. It is directed vertically upward. The noise records are calibrated using a tungsten-filament diode (CV 172) as a matched noise generator.

The cosmic radio waves, emitted by galactic stars, pass through the earth's atmosphere and suffer deviative and absorptive attenuations.

Some results of the analysis of the 25 Mc/s radio waves made at Ahmedabad are presented, including diurnal variation of absorption, and effects of solar flares, and of spread F echoes.

10. K. M. KOTADIA (Ahmedabad) : *Changes in the F2 layer of the ionosphere of low latitudes during magnetic disturbances.*

In this paper (1) an analysis is made of 27 mid-day values of foF2 at Delhi, Ahmedabad, Bombay, Madras and Tiruchirapalli, when its value at Ahmedabad was less than its monthly mean by more than 10%. It was found that there was comparable but smaller mid-day depressions of foF2 at Delhi and Bombay, but that at Madras and Tiruchy, there was mid-day elevation of foF2. The change from a noon day fall of foF2 to a rise takes place at some latitude between Bombay and Madras.

It may be noted that the reversal of the phase of the lunar tide in foF2 also takes place at a latitude between Madras and Bombay. The results are compared with those obtained by Martyn and by Appleton and Pigott.

(2) The changes in the daily variations of hpF2 and foF2 were examined for Delhi, Ahmedabad, Kodaikanal and Kokubunji during seven magnetic storms of SC type which occurred in 1956. A significant general feature of magnetic storms is to produce a marked decrease of foF2 and increase of hpF2 at Ahmedabad, Delhi and Kokubunji and produce the converse effect of increasing the frequency at Kodaikanal. The maximum effect is observed to take place at Ahmedabad. Another interesting feature is a temporary large increase in foF2 at Ahmedabad and Delhi between 8 and 10 hrs. L.T. on many magnetically disturbed days.

The storm time changes in foF2 are analysed relative to monthly medians for Delhi, Ahmedabad and Kodaikanal.

11. R. G. RASTOGI (Ahmedabad) : *On the variation of noon and sub-solar critical frequencies of the E and F1 layers of the ionosphere with solar activity.*

1. Noon critical frequencies of E and F1 vary with sunspot number approximately according to the relation $fo=a\ (1+bR_z)$ where a and b are constants and R_z is the sunspot number. The term "a" corresponds to the critical frequency of the layer for zero sunspot number and "b" indicates the sensitivity of the layer to solar activity.

For the E layer, the value of "a" is a simple function of the noon solar zenith distance and "b" is nearly the same for different latitudes and seasons. On the other hand, the "a" of F1 undergoes a seasonal variation similar to foF2 in middle latitudes with maxima in the equinoctial months.

b(F1) shows a maximum in local summer and minimum in local winter. Moreover, the maximum values of b(F1) are found in middle latitudes with a minimum at the equator.

Thus, while the response of the E layer is mostly due to the photoelectric action of solar radiation, the response of F1 is apparently influenced by the convective movements affecting the F2 layer.

II. The diurnal variation of the critical frequencies of E and F1 can be expressed by a relation of the form $f\ =k\ \cos\chi^n$ where k and n are constants and χ is the zenith distance of the sun. The constants k and n for any place can be determined graphically from the values of foE and foF1 at different hours of the day. k is a measure of the ionisation of the respective layers at normal incidence of solar radiation. The index n is different for E and F1, the value of n(E) being approximately 1/3 and of n(F1) 1/5.

During the low sunspot period Mar.—Apr. 1955, k(E) and n(E) showed a single maximum at the equator, whereas k(F1) and n(F1) showed a trough at the equator and maxima in middle latitudes. During the high sunspot period Sep.—Oct. 1947, the middle latitude peaks in k(F1) and n(F1) were very pronounced.

Although both k(E) and k(F1) increase with sunspot number, the proportional increases of k(F1) differ in different latitudes. For example, at Huancayo kF1 shows very little increase when the sunspot number R exceeds 100, but at stations like Watheroo and Christchurch, kF1 continues to increase even when $R>100$. Stations like Maui and San Juan showed very high values of kF1 in 1947 and 1949.

It seems that during periods of high solar activity, magnetic storms and associated ionospheric disturbances exert a significant influence on the F1 layer.

The changes of k(E) with solar activity are similar in different latitudes.

12. Remarks by Dr. A. K. Das.

13. B. N. BHARGAVA (Kodaikanal) : *Scattering of Radio-waves by Ionospheric F layer and some related geomagnetic phenomena.*

Occurrence of spread F echoes at Kodaikanal for a period of about one year has been analysed and diurnal and seasonal characteristics have been found to exist in the frequency of occurrence of these echoes. It has been found that the phenomenon occurs only during night-time with largest frequency between 19-00 and 04-00 hrs. local time. While the seasonal variation is characterized by equinoctial maxima as in the case of geomagnetic activity, the day-to-day variations in scattering indicate a positive correlation with the degree of magnetic activity. Thus scattering persists for largest percentage of time during comparatively quiet periods and is often altogether absent on magnetically stormy nights. The phenomenon is discussed in relation to ionospheric irregularities and radio-star scintillation.

14. J. V. NARAYANA : *Magnetic Field of Venus.*

Statistical plots of daily equivalent planetary amplitude Ap. similar to magnetic character figure Ci, for 50 days before and 50 days after every inferior conjunction of Venus during the years of low sunspot activity over the period 1884-1955, show that there is a marked decrease in the value of geomagnetic activity about 2 days before the date of conjunction. This asymmetry of the decrease around the date of conjunction suggests a deflection of solar corpuscles by Venus, thereby indicating the presence of some magnetic field surrounding the planet.

Assuming, according to Stomer, an equatorial ring current of about 1 million kms. radius around the earth, the value of the polar magnetic field of Venus works out to about 0·4 gauss. Alternatively, if we assume a ring current of about 10 earth radii according to Martyn, the polar magnetic field of Venus becomes 0·024 gauss.

The above values have been used for computing the rotation period of Venus, assuming that Blackett's empirical formula is applicable to this case. The rotation periods thus obtained are 2 days and 24 days respectively. These values are in better agreement with the faster rotation with a period of a few days estimated by some astronomers, than with the much slower rotation with a period of 225 days obtained by others.

Similar analyses in the cases of Mercury and Moon give no sure indication of the existence of magnetic fields on these bodies.

II. RADIATION HAZARDS AND PROTECTION.

1. DR. V. R. KHANOLKAR (Bombay) : Opened the Symposium.

2. DR. SUBODH MITRA (Calcutta) : *Radiation Hazards and Protection.*

Radiation hazard is a burning question of the day not only for the persons actively engaged in radiation service but also from the point of view of the safety of the general public. Lest we forget I would like to start discussion by paying homage to the martyrs of radiation service since its inception. During the first quarter of a century immediately after the discovery of Roentgen Rays, protective measures were almost non-existent although the research workers were enthusiastically busy with their gas tubes to work out different problems of diagnosis and treatment. The pioneer workers and martyrs in this field of radiation service although chiefly found in Germany and France, can be traced in practically all the well-developed countries. Of the many martyrs of the radiation science, let me mention only a few of the 19th century, namely Albers-Schoenberg, Sister Blandina and Mak. Levy-Dorn of Germany, Alfred Morlet of Belgium, Madame Curie of France, Hall-Edwards of Great Britain, Carlo Infante of Italy, Peter Baumgarten of Russia and Holsknetcht of Vienna.

During the period of World War No. I, use of Roentgen Ray equipment extended rapidly through the introduction of the Coolidge Tube and an alarming increase in radiation burns was noted. This resulted in the prompt and equitable effective measures being developed to cope with the problem.

Until about 1925, the principal uses of radiation were in the medical field. From then on, the industrial use began to increase rapidly and at the same time higher and higher energies were developed for use in medicine, industry and research.

Until about 1943, harmful effects of radiation were limited to the patient, doctor, technician or industrial worker. It could scarcely be regarded as a public health problem though it was beginning to become an industrial or occupational health problem.

Following the advent of atomic energy, radiation from radioactive sources began to be developed in quantity, variety and distribution in magnitudes never before dreamt of. It quickly became clear that within a few years radiation protection had become a serious problem not only as an occupational health problem but as a widespread public health problem and was recognised as much. An additional problem, recently developed, has been more of a psychological nature.

OUR BACKGROUND

We have been carrying on radiation work both investigative as well as clinical for the last 30 years since 1920. The biological standardisation of radiation on Indian skin was done by the writer in 1928 and as suggested by our late great scientist Sir J. C. Bose, the inhibitive effect of radiation on plants was studied and published at the same time. The figure shows how a flowering plant, Pansy, became dwarf with a high dose of radiation as compared with the control series. So far as biological effect on the Indian skin was concerned, we found out that in order to get a Skin Erythema Dose it required 100 r more than the conventional Skin Erythema Dose (550 r) as was than found in European countries. This estimation of the biological dose and its conversion to the physical dose formed the basis of giving treatment without unnecessary radiation hazards. We have started the biological and clinical investigations with radioactive isotopes at the Chittaranjan Cancer Hispital since 1951. The most sensitive criterion for finding out the biological reaction is by the study of the white cells and the red cells of the blood after exposure to radiation. There is a definite fall in the percentage of red cells and white cells with the increasing dose of radioactive isotope P^{32} in animal experiments. Similar reduction of the white cells count is usually found while treating a patient with radiation therapy. If a mammal is left under a powerful x-ray tube or ^{60}Co γ-ray source giving 15,000 r per hour, it dies in 1½ to 3 hours, the cause apparently being the very increased potassium content of the blood, due to the inhibition of cholinerterase after radiation.

The first stage of radiation sickness occurs within the first few hours after moderate irradiation. After the initial stage of a shock period there occurs within 3 to 4 days the increased permeability of capillary endothelium allowing the lymph to be invaded by the red corpuscles; the concentration of the blood is increased by vomiting and diarrhoea; there is mass destruction of the red cells which have invaded the lymph. The animal eats and drinks little. Leucopenia develops gradually and reaches its maximum in 2 to 8 days. On the other hand, if the animals survive, regeneration of leucocytes will begin to show after 8 to 10 days. If the radiation dose is very high the increased permeability of the capillaries persists until death; at autopsy the thoracic duct is often found to be as red as a vein.

The second stage of radiation sickness is the period of haemorrhage, incipient anaemia, infection and malnutrition. Vascular fragility is one of the causes of haemorrhages and the disappearance of blood platelets also accounts fo rit.

The late effects become manifested after the toxic phase, the anaemia and the infections are overcome. There is more or less prolonged sterility. Cataract is frequent as are lymphomas, especially in mice. These lymphomas are homologous with human carcinogenic manifestations of the carcinogenic action if ionising radiations.

What has been found in rats, mice and dogs is equally true in human beings. It has been possible to study radiation hazards comprising all phases after the unprecedented Hiroshima and Nagasaki explosions. Nausea, vomiting, epilation, gastro-intestinal troubles and asthenia occurred in persons who received moderate doses of radiation being far away from the hopocentre. With excessive radiation at the hypocentric region, more pronounced reactions are produced due to heavy concentration of ionisation during radiation. Fatal results are produced due to burns, ocolaryngeal affections, sudden and severe damage of the red and white cells and blood diarrhoea. Those who survived suffered grave anaemia and leucopenia besides other conditions. It has been observed in Hiroshima and Nagasaki that the radiation hazards were minimum provided sufficient protection was available in well-built shelters as well as for the persons who were about 2 miles away from the hypocentre. This naturally leads to the conclusion that protection from radiation hazards can to a great extent be assured if sufficient and adequate safeguards can be vouchsaved.

Coming back to our work-a-day process, health protection service for the workers engaged in radiological work has been found essential. The damage that occur due to long and continued exposures to radiation justifies it. On an average ·3 r is considered to be the maximum limit which a worker can receive per week without any harmful effect. If ·3 r absorbed per week can be calculated for 25 years of active service during active sexual life, it amounts to about 400 r, which according to the geneticists doubles the incidence of spontaneous mutations. I am purposely leaving behind further detailed studies of gene mutations which have been so wonderfully worked out by the Noble Laureate Müller as this has not yet been generally accepted.

The modern x'ray and radioactive units have got adequate arrangements for protection against radiation. But the attitude of most of the workers actively engaged in radiation service in India has not yet been well formed. Most of the radiation hazards occur either because these workers take this affair indifferently or due to non-availability of facilities for checking up radiation absorption.

A full-fledged radiation protection service is the most essential armamentation wherever radiations are utilised either for clinical, industrial or research works. It is essential to have a regular check up of all the personnel engaged directly or indirectly in the Radiological service of any hospital or in private practice. This regular check up is to be done under the following heads and kept in separate files for each individual (as in our practice at Chittaranjan Cancer Hospital) :—

1. Short record of radiological work at present engaged.
2. Previous history of radiological work in other institutions indicating nature of work and approximate duration of exposure to radiation.
3. Examination of nails and finger prints.
4. Blood Examination.
5. Checking up of absorption of radiation by
    (a) Film badge technique,
    (b) Pocket Ionisation Chambers.

Use of ionisation chambers are suitable for places where comparatively less number of people are involved. But for big establishments the film badge technique (photographic method) has tremendous advantages both from the point of view of economy and efficiency. With a centralised unit it is very easy to have a control over a wide area, bringing within its fold all the people directly or indirectly connected with radiation within the state.

In actual practice special personnel monitoring films loaded in specially designed cassettes will be distributed to each individual. These will be worn by the personnel as a badge for a speciked period and returned back to the institute after that period. These films will be developed under standard condition and studied under a densitometer for assessing the dosage of radiation. These films will be preserved as permanent records of radiation received by any particular individual for a particular period. In case of the persons receiving higher than the tolerance dose, methods of protection and precautions to be taken to be suggested. Apart from this, periodic blood counts, physical examination of skin, nails, etc. will also be done and records of these preserved.

I would like to end this lecture by presenting before you a demonstration diagram showing the weekly absorption of radiation of one of my workers at the Cancer Hospital. The diagram shows that this particular worker has never got more than ·2 r. in one week. The haemoglobin and the red cells count show fairly constant, whereas there was a slight drop of the white cells count at the end of the third week. Increased absorption of radiation up to ·2 r in the second week and the fall of white cells in the third week put us on guard and his case received our particular attention. If the protection service is carried on systematically as it is done in the Chittaranjan Cancer Hospital, I am sure one can avoid hazards of radiation very effectively.

3. A. S. RAO (Bombay) : *Health Physics Instrumentation and Protection against Radiation Hazards.*

The methods and instruments used in India for the monitoring of radiations and radioactive contaminants may be classified as those for (1) monitoring airborne radioactive substance, (2) the survey of alpha, beta, gamma radiations and neutrons in different areas and (3) personnel monitoring. Airborne radioactive substances are monitored using continuous filtering-detecting devices and static filter paper samplers. The activity of the samples is measured by means of Geiger counters, proportional counters and scintillation counters. Radon and thoron activities in the air are assessed independently of other isotopes using 'ion collection technique'.

Portable and semi-portable instruments using Geiger counters, proportional counters and scintillation counters are employed for the survey of areas for different types of radiation. Ionisation chambers are used for continuously measuring radiation level in the areas around the Swimming Pool Reactor.

For personnel monitoring film badges containing Ilford Ph-1 film are used for beta and gamma radiation. Pocket ionisation chambers and dosimeters of different ranges are also used for personnel monitoring.

Protection against radiation hazards is discussed in detail.

4. DR. SANTIMAY CHATTERJEE : *Radioactive fall outs from the nuclear explosions.*

A summary of the observations made at the Institute of Nuclear Physics on the amount and nature of radioactivity found in the atmosphere and in the rains will be presented. An estimate of the relative radioactive dosage of natural radioactivity, cosmic radiation and radioactivity of nuclear explosions will be given.

5. A. R. GOPAL-AYENGAR, Biology Division (Bombay) : *Genetical Implication of Radiation.*

The deleterious effects of exposure to ionizing radiations have been a matter of serious import for many years, but so long as exposures were limited to special categories of people like radiologists and their patients as well as those occupationally concerned with industrial and research pursuits demanding radioactive materials and processes, the question of effective control measures and protective policies was in the main a technical and educational concern for Health physicists.

With the development of reactor technology, installations for power production involving nuclear energy and other peace time applications of atomic radiation, and the inevitable rise in background levels of radiation consequent upon test explosions of nuclear devices, possibilities of entire populations being subjected to increasing amounts of radiation become very real indeed. The question of long term effects of radiation on man and his environment thus becomes a problem of public health responsibility. Several other questions arise in this connection : What, for instance is the magnitude of human exposures to natural and man-made radiations from such diverse sources as background radiation, medical x-rays, radioactive fall-out etc ? What should be the lines along which policies should be formulated concerning nuclear weapons tests, nuclear power plants, experimental reactor installations, other types of radiation exposure including radioactive wastes ? Most of the information about the genetical implications of radiation has been obtained from work with Drosophila and more recently at the mammalian level with mice. Although the quantitative assessment of genetic hazards of human populations is beset with technical difficulties and extrapolation of data from lower levels of integration to man may be open to criticism, some measure of evaluation is necessary and within limits possible. Two questions are of paramount consideration in this connection : These are : How many mutations are produced for a given dose of radiation and what effect will such mutant genes have ?

In an attempt to understand the totality of genetical effects of radiation it would be necessary to consider the problem from a wide salient. Briefly, the following aspects are of particular interest : Somatic effects, Induction of cancer and Leukemia, effects on germ cells, changes in chromosome structure, induction of gene mutations, proportionality of dose and effect, the relationship between the amount of radiation on the one hand and the spectrum of damage on the other, such as viability, fecundity, growth rate, congenital malformations etc., concept of doubling dose and the consequences of doubling mutational rates on diseases due to dominant, sex-linked or recessive genes, long-term consequences of accumulation of deleterious genes, present concepts of permissible doses and formulation of radiation policies for the future on genetical basis, consideration of recent reports on hazards of nuclear and allied radiations.

Finally, it cannot be too strongly emphasized that despite the quantitative inadequacy of human data, the genetic hazard of radiation is real and even a slight increase in the natural background radiation level would add to the mutational load resulting ultimately in a harvest of defective individuals in generations yet unborn.

6. K. C. BORA (Bombay) : *Relative Biological Efficiencies of Different Ionizing Radiations.*

Relative Biological Efficiency (RBE) of a radiation, as compared to another, is defined by the ratio of the two doses of the radiations delivered at the same dosage rate under comparable environmental conditions and producing the same amount of biological effect of a particular type, either in the same tissue or in identical tissues. Experimental evidence shows that RBE of different ionizing radiations *i.e.*, X-, gama-, beta- and alpha rays and neutrons in causing a variety of biological effects such as lethality, mutation, chromosomal aberrations, loss of weight etc., depends primarily on the Linear Energy Transfer (LET) or Rate of Energy Loss (REL) per unit length of the track of the ionizing particle in the tissue. The RBE of a radiation is a variable factor depending on the nature of the biological material, the type of effect, the manner in which a dose is delivered, the physical compounds of a radiation beam, the matabolic and the genetical set up of the material, environmental conditions etc. Since the common denominator for evaluating RBE is the radiation dose the correct measurement of the dose is of utmost importance.

Several methods of dosimetry are discussed and the values of RBE critically examined. A survey of the factors influencing the RBE values is made.

It is generally agreed that the fast neutrons and alpha rays are the most and the high energy X- and Gama rays the least efficient in causing types of biological damage examined so far in the macro-organisms.

7. DR. N. B. ROY (Calcutta) : *Remarks on Radiation Hazards in Radiotherapy.*

In a symposium like this there is likely to be a lot of overlapping. In an attempt to reduce this overlapping to a minimum, I small confine my observations to the radiation hazards that are likely to arise in and due to the routine-work of a fair-sized department of Radiotherapy of a general or special hospital.

The Hazards that might arise can conveniently be discussed under three different sections :

1. Hazards to the Staff.
2. Hazards to the patients.
3. Hazards to the public.

The problem is really a three-fold one :

1. We have to adopt measures to protect ourselves and those workers associated with us against the effects of repeated small doses of radiation received over the whole working life-time..

2. We have to protect our patients so far as the doses delivered are reduced to the minimum necessary compatible with successful treatment.

3. In the case of radio-isotopes, we have to protect the public, both by control of the discharge of the isotopes into the sewerage system and by ensuring that the contamination of the soiled bed-linen which is to be sent to public laundries is below a certain level.

Let us discuss these problems, one by one :

I. Hazards to the staff—

Hazards to the workers might arise :

(*a*) By ingestion of radium or isotopes with affinity for bone or other organ;
(*b*) By inhalation of radon or some of the less soluble isotopes causing lung damage;
(*c*) By actual handling of radium or isotopes with consequent damage to fingers;
(*d*) By continuous or intermittent exposure of the body to radiation over a prolonged period, which is likely to cause;
  (*i*) Damage to reproductive organs *e.g.*, tests and ovary;
  (*ii*) General malaise, tiredness, inability to concentrate—a very mild form of radiation-sickness.
  (*iii*) Blood-changes. This will be dealt with fully by Dr. C. R. Das Gupta and hence I am not going to elaborate on this important aspect.

I shall not enter into the problem of hazards from actual ingestion or inhalation, as I am sure that aspect will be touched upon by other speakers. As far as the problem of actual handling of radium or isotopes is concerned, measures should be taken to avoid actual contamination with radon or isotopes, special gloves should be used, long-handled forceps should be used to increase the distance in handling radium, speed in handling should be insisted upon and supervised, radon should be handled only when 'inactive', general cleanliness of hands should be insisted upon, trauma to the hands should be avoided at any time. In addition, periodic examination of the workers' hands should be carried out as a routine every three months. Coming to the problem of continuous exposure for a prolonged period. We must remember that the International Commission on Radiological protection, having considered such radiation effects as blood-changes, carcinogenesis, cataract-formation, impaired fertility and genetic effects, has concluded that as far as X'Rays and gamma-rays from sources external to the body of a radiological worker are concerned, in circumstances under which the whole body may be exposed over an indefinite period tò X'radiation or gamma-radiation of quantum energy less than 3 m.e.v., the maximum permissible dose received by the surface of the body shall be 0·5 rontgen in any one week. This dose corresponds to 0·3 rontgen per week measured in free air. In putting forward this value and others for other types of ionising radiations, the Commission stresses the fact that, in view of the unsatisfactory nature of much of the evidence on which our judgments must be based, coupled with the knowledge that certain radiation effects are irreversible and cumulative (for example, genetic effects) every effort should be made to reduce exposures to all types of ionising radiations to the lowest possible level. Methods of protection usually undertaken to guard against these general irradiation effects are :

1. *Distance* : The actual designing of rooms in a department of Radiotherapy and Instructions to staff should be so arranged as to get the maximum possible protection from distance.
2. *Working conditions* :
   (*a*) Rotation of duties *e.g.*, one month in Radium Lab. and next month in Mould Room.
   (*b*) *Division of duties*—Once a week in operation theatre handling Radium.
   (*c*) *Short-term service*—for technicians.
   (*d*) Holidays.
3. Speed in working.
4. *Lead protection devices* :
   (*a*) Efficient Radium safe.
   (*b*) Lead Boxes—In Radium Lab., In Wards, In operation Theatre.
   (*c*) Lead work-benches (L. shaped).
   (*d*) Lead carrying devices with suitable modifications for internal and external transport.
5. Regular Blood-counts : Special stress should be laid on—
   Lymphocytosis with neutropenia
   or
   Lymphocytopenia with monocytosis and finally Leukopenia.
6. Monitoring devices :
   (*a*) measurements of stray radiations at different parts of the building must be sufficiently low and, preferably, lower than the permissible level;
   (*b*) individual workers should have either a film badge or a pocket minometer which should be regularly checked up by the physicist. This subject will be dealt with in detail by Dr. Subodh Mitra.

II. *Hazards to the patients* : These might arise :

1. From inaccurate dosmetry.

2. Insufficient experience or error of judgment of radiotherapist in assessing proper dose.
3. Inaccurate application or error (e.g. in changing a filter or in adjusting the time) of the radiographer.
4. Error in protecting vital organs where possible e.g. eyes, gonads, etc.

These hazards are likely to involve Skin, mucous membrane, cartilage and bone and have been seen in varying degrees of severity depending upon the type of error. To a very large extent, these hazards can be prevented with care and judgment.

III. *Hazards to the public* :

These hazards might arise if radioactive waste is not controlled properly. Contamination of drinking-water supplies and serious accumulation of activity in soil and mud, in grass and fish must be avoided. Radioactive waste may consist of contaminated glass-ware, of liquids, of absorbent papers used in the preparation of doses, of surplus radioactive material, of radioactive excreta from patients, of contaminated bed-linen and of contaminated clothing of patients and staff. This itself is a big subject and, I am suie, will be dealt with by some other speaker. My object is to bring your attention to this growing problem which must be adequately handled to protect our population.

8. N. L. RAMANATHAN, B. B. CHATTERJEE and M. N. RAO (Calcutta) : *A Health-Physical Survey of Medical X-Ray Installations in Calcutta.*

In this survey (*i*) the evaluation of the status of the environment, (*ii*) the evaluation of the status of the X-ray source and protection practice adopted by the personnel, (*iii*) the determination of the radiation intensity at a standard reference position (1 meter distant from the source in the transverse direction) and the weekly radiation exposure of the operating technician and (*iv*) a detailed medical and haemotological examination of the personnel have been made in 15 medical X-ray establishments of various types in Calcutta.

From the results of the environmental investigations, it is found that (*i*) exposure to injurious levels of radiation is possible in many installations, (*ii*) the design and layout of many X-rays rooms are unsatisfactory, and (*iii*) protection techniques are not usually resorted to and if employed, they are not adequate. The question of the potential hazard has been discussed in detail from the point of view of protection.

The medical and clinical screening of the personnel revealed one positive case of healed radiation dermatitis and three doubtful cases of significant abnormality of blood configuration. It was not possible to relate the blood pictures to the radiation exposure due to (*i*) the inherent lack of sensitivity and specificity of the blood test and (*ii*) the absence of exposure records.

For each installation, appropriate preventive and precautionary measures were designed and submitted to the authorities. Suitable recommendations regarding the general protection techniques applicable in these installations have been made. In addition, proposals for the establishment of a central authority for the organisation and control of protection in the use of X-rays have been presented.

9. S. R. MUKHERJEE and Miss P. PARVATHI (Calcutta) : *Radioisotopes : Dangers in indiscriminate uses.*

Any drug, if administered without previous knowledge about its mode of action and its safety dosages and without the knowledge of countermeasures to combat the untoward effects of the drug, is dangerous. Similar fate is in case of indiscriminate use of Radioactive Isotopes,

So none should use radioactive isotopes unless (1) it is essentially the only available and suitable agent (therapeutic or investigative) to be used, (2) unless technologically it is a well planned and well organised unit in handling such isotopes and (3) lastly dosimetrically controlled.

The disastrous effects of acute irradiation poisoning present a more horrifying picture than one can imagine or even can visualise.

The syndrome of acute radiation illness is initiated and continued by the following mechanisms :

(1) inhibition of the enzymatic reactions in the body;
(2) the alteration in the cell membrane permeability;
(3) the denaturation of proteins in the body;
(4) production of toxins in the body—their absorption and circulation;
(5) auto sensitization;
(6) adrenocortical failure;
(7) general adaptation syndrome.

The detailed picture cannot be briefly summarized but some picture taken from standard text books will be shown.

The unforeseen and unpredictable bad results can only be assessed by the third or fourth generation in future when the mutation effects will be properly, adequately and sincerely assessed. Meanwhile it could be stated that the effects are far more disastrous biologically than can be conceived.

The continued effects of irradiation in a general and wide scale measure can be studied by the public health section and the nuclear physicists working in a combined manner. The contamination of water, soil, the crops and the vegetation and naturally the pasture animals will remain ever sources of contamination to the human population. Such results can also be the consequences of ill-planned, inadequately designed radioactive laboratories. In this connection, contamination of sinks, pipes, water drainage, sewage, rivers or tanks acting as final drains has to be remembered. Ignorant uses and disposal of radioactive stuffs from such contaminated sources or from rash and disorderly uses in clinical fields will produce more horror and bring "infame" to the radioactive uses.

A close collaboration of the public health section and the sanitary engineers is urgently needed.

The effects of slow chronic radiation poisoning can be remembered as the cause of death of many an investigator in radiation laboratories. Similar picture can be obtained if any devoted student in this line reads how the fatal end came to the life of Madam Curie. Summarily the pathological physiology of chronic radiation illness is due to (*a*) aplasia of bone marrow—Pancytopenia, (*b*) reducing body resistance to infections due to progressively increasing lack of the defensive cells of the body, (*c*) selective action of the radioisotopes in any particular site.

It does not necessarily mean that the hazards in the uses of radioactive isotopes stand in their uses. On the contrary, it signifies that new tools of research are available from physics for more precise investigations in biology and medicine. It is essential to have a close collaboration of the physicists, laboratory and clinical investigators. When a team is integrated in this manner and works in a planned fashion only, the hazards of radioactive illness will be reduced to nil.

10. R. K. PODDAR, (Calcutta) : *Radiation Dosimetry with Photographic Emulsion.*

The use of photographic emulsion for quantitative measurement of the dose or the quantity of radiation is of relatively recent origin. At present, however, dosimetry of external radiations from x-ray, gamma ray and beta particle sources is routinely carried out with the help of photographic emulsions in all the radiation laboratories of the world. As the radio-active isotopes are being widely applied in medical, biological and industrial research, as well as in therapy and diagnosis, the problem of quantitative measurement of the doses due to ingested radiation sources is also demanding an urgent solution. This is essential for the correct estimate of the maximum permissible concentration with respect to radiation protection and health hazards of working personnel.

To obtain a quantitative relation between the isotopic radiation and the photographic response, studies have been made of the variation of photographic density with the quantity and quality of radiation. The methods and results of these studies are discussed.

In order to measure the doses received by the so-caled "hot spots" in the case of ingested radio isotopes, a study of localisation of radioactive iodine (I-131) by the thyroid gland at the cellular level has been made with the help of photographic emulsion. The relative doses received by different regions of the thyroid gland due to I-131 have been determined from the measurement of grain density of the autoradiographs of thyroid sections. The experimental methods and the significance of results are discussed.

I. CHEMOTHERAPY OF BACTERIAL CELLS

Section of Chemistry

Chairman : PROF. S. M. MEHTA, Bombay.

1. DR. B. MUKERJI (Lucknow) opened the Symposium and gave a historical review of the subject.

2. A. SREENIVASAN (Bombay) : *Mechanism of Sulphonamide bacteriostasis in Escherichia coli.*

The reversal of sulphanilamide growth inhibition of *E. coli* by p-aminobenzoic acid (pABA) suggested a metabolite-analogue-antagonist relationship between the drug and the vitamin. The known reversing action of structurally unrelated substances like certain amino acids, purines and B vitamins was explained as due to their being products of pABA-associated enzyme systems. The drug blocks sequentially the formation of methionine, xanthine, serine, thymine (or folic acid) and valine; the inhibition index at every stage is increased in presence of vitamin B_{12}. This additional function of vitamin B_{12} is also observable in our studies with an *E. coli* B_{12} aurotroph; vitamin B_{12} and methionine are interchangeable for growth in this organism. But methionine could produce reversal of sulphanilamide growth inhibition comparable to that with vitamin B_{12} only after supplementation with xanthine and serine (Bioch. Biophys. Acta, *18,* 567, 1955).

Even though it has been shown that sulphanilamide inhibits sequentially the biosynthesis of methionine, xanthine, serine, thymine and valine, it has not been possible to reverse growth inhibition by the drug using a combination of these metabolites with the same effectiveness as with pABA. It is now shown (*Nature, 176,* 702, 1955) that in addition to the foregoing metabolites, glycine and vitamin B_{12} together with substitution of xanthine by a mixture of purines, bring about reversal of sulphanilamide effect comparable to that with pABA.

Although a folic acid derivative may be the active coenzyme form of pABA, in *E. coli,* pteroyl-glutamic acid is found unable to substitute for pABA. This observation is explained from studies on (1) the differential nature (based on growth characteristics, inhibition analysis and bioautography) of the folic acid, active substance biosynthesized by *E. coli,* from pteroylglutamic acid and leucovorin, and (2) the inability of *E. coli* cells to take up exogenous pteroyl glutamic acid or leucovorin.

3. NITYA NAND and M. L. DHAR (Lucknow) : *Chemotherapy of mycobacterial infections.*

On the assumption that permeability constitutes one of the most important limiting factors in the effectiveness of antimycobacterial agents a number of derivatives of diamino diphenyl sulfone have been prepared, with a view to include in the molecular architecture biologically stable groupings that would confer upon the molecule an optimal fat/water solubility ratio, and thus help in concentrating these compounds at the site of infection.

Eight series of compounds carrying different types of groupings, which would confer varying amount of fat/water solubility ratio on the molecule, have been prepared. The results of the *in vivo* testing of some of the representative compounds of the various series show that three compounds were as active as INH and Streptomycin.

The metabolism of a few of these compounds show that these compounds after oral administration are almost completely absorbed into the system from the stomach, stay in the system for a long time, and are very gradually excreted from the system mainly via the kidnies and to some extent via the intestines. The main seat of metabolic alteration seems to be the kidney and in the case of alkylamino compounds, dealkylation is the main mode of detoxification.

4. M. L. KHORANA (Bombay) : *Anti-infective derivatives of β-naphthol.*

From the time phenol was used as antiseptic in surgery by Lister a number of derivatives of phenol have been prepared and studied with a view to getting a better product. In spite of the newer developments in the field such as sulpha drugs, antibiotics, organo-metallic compounds, etc., chlorinated cresols and xylenols are still commonly used for mouth washes and local applications. Similarly hexyl resorcinol and diphenan are used for intestinal parasites, PAS for T.B. and hexachlorophene as a soap antiseptic. Though naphthols were known for a long time to possess good anti-infective properties and β-naphthol was used in medicine for some time, compared to that on phenol derivatives very little work had been done on the naphthol derivatives. This work was started in our laboratories about seven years back. In all about 250 compounds have been prepared and studied. Major portion of this work covers derivatives of β-naphthol. 6. alkyl-, di-and tribromonaphthols, esters of 2-hyroxy-6-naphthoic acid, and 2-hydroxy-3-naphthoic acid, have proved to be very promising. They have been further tested for their activity in presence of organic matter, for their toxicity, irritation to skin etc. and have compared very favourably with some other compounds now in common use as anti-infective agents.

II. METABOLIC ASPECTS OF VITAMINS

Chairman : PROF. S. M. MEHTA, Bombay.

1. P. R. KRISHNASWAMY and K. V. GIRI (Bangalore) : *Studies on Riboflavin metabolism in yeast.*

Some aspects of riboflavin metabolism in a riboflavin-excreting mutant yeast BY2 have been investigated. The organism was found to excrete the two biologically important flavin derivatives, flavin mononucleotide and flavin-adenine dinucleotide, in addition to riboflavin. The two important enzymes concerned in riboflavin metabolism in yeast viz. 'flavokinase' and 'nucleotide pyrophosphatase' have been studied in detail in the parent as well as the mutant yeasts. Data will be presented to show the variations in these enzyme activities under different environmental conditions during the growth of the organism. Cells grown under conditions favourable for riboflavin excretion showed less activity in the synthesis of the flavin mono-and-adenine dinucleotides than those cultivated in unfavourable conditions for riboflavin excretion. The reaction in which flavins were found to be synthesised *in vitro* by cell-free preparations of the organism with α-ketoglutaric acid and 4-amino 5-imidazole carboxamide was followed and previous observations on the role of purines as precursors in flavinogenesis in this organism will be discussed. Further, studies on other forms of riboflavin metabolism like trans-glucosidation which are in progress, will be presented. Chromatographic procedures were employed for the study of these metabolic processes.

2. A. SREENIVASAN (Bombay) : *Interrelationships between folic acid and vitamin B_{12}.*

Folic acid and vitamin B_{12} have apparently closely related biochemical functions other than their established involvement in heaemopoiesis. Among these may be mentioned the metabolism of choline, methionine, glycine, serine, tyrosine and possibly other amino acids and nucleotides. Of special significance is their participation in trans-methylations and generally in single carbon addition reactions.

In spite of several reports relating to the sparing action of either or both the vitamins for choline and methionine, there has not as yet been shown a clearcut and dissociable difference in the biochemical pathways influenced by them. Data obtained in this laboratory on the *in vitro* and *in vivo* formation of creatine (*Nature, 167,* 1067, 1951; *170,* 894, 1952; *Ind. J. Med. Res., 43,* 337, 1955) and N-methylnicotinamide (*Nature, 169,* 1096, 1952; *Ind. J. Med. Res., 43,* 343, 1955; *Biochem. J., 59,* 470, 1955) with experimental mice and rats under different dietary conditions and in deficiencies of the two vitamins are interpretable on the basis that folic acid influences trans-methylations only indirectly by enabling better utilization of formate and other precursors of a 1-C fragment and thereby checking a drain of the labile methyl into the formate pool (*Nature, 173,* 359, 1954). Vitamin B_{12} probably aids in the neogenesis of this 1-C moiety (*Ind. J. Med. Res., 43,* 349, 1955) Supporting evidence for this postulate is reviewed.

In an attempt to elucidate the functions of folic acid and vitamin B_{12} in nucleotide metabolism, microorganism specifically requiring either of the vitamins for growth were employed for a study of their ribonucleic and deoxyribonucleic acid syntheses as influenced by the two vitamins. The respective vitamin was observed to influence deoxyribonucleic acid synthesis (*Nature 166,* 1117, 1950). Withholding the purines and uracil from the growth medium impaired ribonucleic acid synthesis as well (*J. Biol. Chem., 210,* 373, 1954). Besides, in folic acid requiring organisms, a supplement of vitamin B_{12}, though not influencing growth, potentiated folic acid action. These observations together with the known replaceability of folic acid by purines and thymine and of vitamin B_{12} by deoxyribonucleosides, especially thymidine, would suggest a function for the two vitamins at different steps in the sequence of reactions leading to synthesis of nucleotides; folic acid in the synthesis of bases and vitamin B_{12} in nucleosixation and trans-nucleosidation. Vitamin B_{12} may be involved, additionally, in deoxyribose synthesis.

Observations such as (i) protection by the two vitamins against antibiotic action in microorganisms (*Nature, 173,* 728, 1954) and (ii) mediation in uracil to thymine conversion (*J. Biol. Chem., 209,* 471, 1954) would, however, serve to emphasize the overlapping of their influence on certain metabolic systems.

3. B. M. BRAGANCA, I. ARVINDAKSHAN, U. W. KENKARE and D. S. GHANEKAR (Bombay) : *Enzymic Degradation of Folic Acid by Animal Tissues.*

Although the inactivation of folic acid by tissues has been reported by several authors, there is little knowledge about the specific enzymes or the pathways involved in such a metabolic disposal of folic acid.

In a previous communication to the Science Congress from this laboratory, it was shown that human blood cells contained a factor which oxidatively degraded folic acid under very low pH conditions. Extension of these investigations has demonstrated that blood cells and liver, can actively degrade folic acid at the junction between the pteridine moiety and the pABA portion under physiological pH conditions.

Extracts of human blood cells prepared by ammonium sulphate fractionation have been found to liberate a diazotizable amine from folic acid, with a concomitant formation of an aldehyde. The loss in streptococcus faecalis activity encountered on incubation of folic acid with this system can be shown to be equivalent to the diazotizable amine produced. The enzyme system shows optimum activity at pH 5·5. It is completely inactivated by dialysis and the activity may be regained by addition of a heated extract prepared from blood. The natural cofactors supplied by the heated extract may be replaced by a system consisting of ATP, Mn^{++} and glutathione. The enzyme specifically degrades folic acid and does not attack folinic acid or Amethopterin. The latter two compounds are found to inhibit the degradation of folic acid by this enzyme system. Evidence is presented to show that normal human blood cells contain a natural inhibitor for this enzyme which in some of its properties resembles a protein.

Enzymes liberating the diazotizable amine from folic acid appear to be widely distributed. The preparation and properties of enzymes from rat and sheep liver which bring about similar degradation of folic acid will be described. The wide distribution of these enzymes suggests that this may be the major route for the biological disposal of folic acid and also for the biosynthesis of Pteridine derivatives like Xanthopterin which in recent years have been implicated in growth processes.

4. M. C. NATH (Nagpur) : *Acetoacetate in relation to Metabolic and Biogenetic Pathways of Vitamin C.*

Acetoacetate, which on repeated injection to normal animals has been shown, in a series of publications from this Department, to develop experimental diabetes accompanied with depletion in blood GSH, has also been found to cause marked depletion in the ascorbic acid content of the blood. This decrease has been much more pronounced in scorbutic guinea pigs. When acetoacetate was injected to scorbutic animals in the dose of 600 mg/kg the level of ascorbic acid in kidney, liver and spleen fell to zero within 24 hours after injections, and the concentration of dehydroascorbic acid which has, in recent years, been known to be one of the diabetogenic compounds, was found to be accumulated in those tissues. Depletion of ascorbic acid and accumulation of dehydroascorbic acid have also been observed in the blood and tissues of normal rabbits injected acetoacetate in the daily dose of 600 mg/kg for 21 days.

It is reasonable to assume, therefore, that acetoacetate by depletion of reduced glutathione, which has been known to prevent experimental diabetes and by increasing the level of dehydroascorbic acid in the blood and tissues exerts its diabetogenic effect while administered for a long time in the experimental animals.

But while acetoacetate is allowed to condense with glucose to give rise to glucose-cyclo-acetoacetate it is not only harmless but can prevent experimental diabetes through alloxan, dehydroascorbic acid as well as acetoacetate.

It has also been possible to show from this Laboratory that glucose-cyclo-acetoacetate serves to act as a much better precursor to ascorbic acid than glucose. This work has recently been done with germinating mung bean as well as in rats and has recently been confirmed by other workers, who took recourse to radioactive glucose and glucose-cyclo-acetoacetate. The yield of ascorbic acid with the latter has been shown by them to be 5-6 times higher than that with glucose alone.

Although glucose has long been known to be the precursor for vitamin C biosynthesis the precise mechanism by which it is transformed to ascorbic acid was not known so far. It is hoped that this work will throw some light on such mechanism.

5. P. SESHADRI SASTRY, S. KRISHNA MURTHY and J. GANGULY (Bangalore) : *Vitamin A Esterase.*

The distribution of vitamin A esterase activity in various tissues of the rat was studied with vitamin A acetate, stearate, palmitate and oleate. Liver was active against the acetate only, while pancreas, small intestine, spleen and kidneys were active against all the four esters and blood plasma showed slight activity against the acetate. Red blood cells were completely free of activity against all the four esters of vitamin A.

Rat-liver vitamin A esterase showed two pH optima at pH 6·6 and at pH 8·6, the maximum activity being obtained at pH 8·6. The substrate optimum of the liver enzyme was at a concentration of $6 \times 10^{-4}M$ above which concentration the activity decreased sharply with increasing concentration.

Various metabolic ions, a few alkaloids and arsenicals were tested for their effect on the activity of the liver enzyme with respect to vitamin A acetate and ethyl butyrate as substrates. Many of these agents preferentially inhibited vitamin A esterase activity, while having no effect on the esterase activity. Acetone drying of the liver caused almost complete loss of vitamin A esterase activity, while retaining most of the esterase activity. The vitamin A esterase activity of rat-liver homogenate on aging at 5°C went down rapidly from the sixth day onwards, whereas the esterase activity was retained almost unchanged even upto the fifteenth day. Heat inactivation studies with liver homogenate showed that the vitamin A esterase activity was rapidly lost at 50°C, while the esterase activity was retained even up to 65°C. These studies indicate that the vitamin A esterase activity is more labile than the esterase activity and it is, therefore, possible that the two enzymes are not identical.

The possible mechanism of regulation of vitamin A alcohol level in blood and liver will be discussed.

6. P. S. SARMA (Madras) : *Certain Aspects of Metabolism of Nicotinic Acid and Nicotinamide.*

The metabolism of nicotinic acid and of nicotinamide has been studied in the albino rat as also in lower organism like rice moth larvae (*Corcyra cephalonica st.*) and in *Neurospora crassa*. Investigations carried out in recent years on the metabolism of nicotinic acid in the rat reveal that nicotinuric acid, the glycine conjugate of nicotinic acid is probably not a major end product of the metabolism of the vitamin when it is administered in physiological dosage, but is extensively excreted when massive doses of nicotinic acid are given to the animal. The glycine conjugate thus is to be regarded more as a 'detoxication' product of the extra physiological quantities of nicotinic acid than as a normal metabolite of the vitamin. In normal and pantothenate deficient rats, the metabolism of nicotinic acid has been studied with particular reference to the excretion of nicotinuric acid and it was found that whereas nicotinuric acid constitutes about sixty per cent of the tertiary derivatives of nicotinic acid excreted by control rats, it accounts for a markedly *lower* proportion of the tertiary derivatives in the case of the pantothenate-deficient animals showing thereby that co-enzyme A is involved in the biosynthesis of nicotinuric acid in the same manner as in the case of enzymic synthesis of hippuric acid from benzoic acid and glycine.

Again, while N'-methyl nicotinamide is the chief end product of the metabolism of nicotinic acid when administered to rats in physiological amounts, in case of rice moth larvae, this vitamin is not methylated and the main excretory metabolite is free nicotinic acid irrespective of whether nicotinic acid or nicotinamide is given in the larval diet. To a smaller but significant extent (of about 30%) the glycine conjugate, nicotinuric acid is found in the larval excretion, irrespective of whether nicotinic acid or nicotinamide is originally administered to the experimental organism. The mould *Neurospora crassa* differs to a slight extent from *Corcyra* in that it neither methylates the vitamin nor conjugates it with glycine. The metabolic end product is always free nicotinic acid even though the vitamin is originally supplied in the amide form.

It has been possible to demonstrate the presence of an enzyme both in rice moth larvae and in *Neurospora crassa* which can bring about deamidation of nicotinamide. The locale of the enzyme has been found to be the supernatant fraction obtained by Schneider's low temperature differential centrifugation method. This enzyme has been purified and its properties have been studied.

III. MAGNETO-CHEMISTRY.

Chairman : PROF. S. M. MEHTA, Bombay.

1. PROF. P. RAY (Calcutta) opened the Symposium, gave a historical review and drew attention to certain theoretical aspects of the subject.

2. S. S. DHARMATTI (Bombay) : *The rôle of Nuclear Magnetism in the study of the structure of matter.*

Although the magnetic properties of nuclei have been known to us for over the last 25 years, their effects in bulk samples have been revealed only during the last decade with the advent of extremely precise and highly sensitive experimental methods developed since 1946. The modern nuclear magnetic resonance spectrometers have now a resolution of the order of 1 part in 10^7 and the nuclear magnetic moment measurements with such high resolution radio frequency spectrometers have led significantly to the understanding of the delicate and the detailed structure of matter. Information such as the chemical shift and the indirect spin-spin coupling, chemical exchange, molecular structure and molecular association, internuclear distances and the types of molecular motions, the nature of molecular bonds and the crystal structure can be obtained by the study of nuclear magnetic moments and the associated measurements. These general features of nuclear magnetic resonance in the field of chemical research will be discussed.

3. D. D. KHANOLKAR (Bombay) : *Diamagnetism and molecular structure : Magnetic susceptibilities of organic isomeric compounds.*

Pascal has shown that in homopolar compounds the molar diamagnetic susceptibility is an additive property and is given by the expression $\chi_M = \Sigma n_A \chi_A + \lambda$ where n_A is the number of atoms of susceptibility χ_A in the molecule and λ is a constitutive correction factor. The value of λ has been found to depend on the nature of bonds between the atoms. This indicates the constitutive nature of diamagnetic susceptibility. This can be tested by a systematic and a thorough study of organic isomeric compounds. The systematic work done by Bhatnagar and coworkers, Angus and coworkers, Trew, French and others has shown that there are small but significant differences in the susceptibility values of isomeric compounds and these could be explained on the basis of the structure of these compounds. The work done by the author on a large number of disubstituted benzenes at the University College of North Wales, Bangor has clearly shown that it is possible to correlate the orienting effects of different substituent groups with the molar susceptibilities of the compounds in which these groups are present. It may therefore be concluded that though diamagnetic polarisation cannot be employed independently for the determination of structure of molecules it is certainly an important tool for corroborating evidence regarding molecular structure obtained from other physical properties.

4. A. S. CHAKRAVARTY (Calcutta) : *Discussions on the Modern Theories of Paramagnetism in Crystals.*

In order to explain the anisotropic behaviour of the central paramagnetic ion in the crystals, various theories have been proposed. It has been first pointed out by Van Vleck that the central paramagnetic ion is under the influence of the electrostatic field produced by the surrounding diamagnetic ions—their influences being either direct or indirect. The nature and symmetry of distribution of these diamagnetic ions will therefore determine the anisotropic behaviour of the paramagnetic ion. While the crystalline electric field theory of Van Vleck and others does not take much account of the spins, the Spin-Hamiltonian method of the resonance workers which takes into account of the lowest electronic energy levels of the ion, considers the spin-interactions to be of primary importance. Lastly, the Theory of Molecular Orbitals of Mulliken, Van Vleck and others, which has also been applied in certain cases, differs from the crystal field theory in that the structural unit for the wave-function is the whole complete ion rather than the single central atom. It may, however, be noted here that each of these theories though capable of explaining qualitatively and to some extent quantitatively the paramagnetic behaviours of the crystals, are unable to explain exactly all the experimental results obtained here as well as elsewhere. An attempt has therefore been made in this short discourse to analyse critically the developments of these theories with a view to indicate the possibility of a suitable theory which when properly developed will be able to explain all the facts observed.

5. S. K. DUTTA (Calcutta) : *The Paramagnetic behaviour of some similarly constituted salts of the elements of Iron Group.*

The paramagnetic anisotropy of a large number of single crystals of similarly constituted hydrated salts of Cu^{++} and Ni^{++} ions has been studied, using improved methods of measurement. The following interesting results have been observed : (1) The directions of the principal magnetic axes in the crystal, where not uniquely fixed by the crystal symmetry, change in general with temperature, (2) Assuming a tetragonal symmetry it is found in the present series of salts from structural and other considerations, that the ionic anisotropy is $K_{\parallel}-K_{\perp}$ for the Cu^{++} ion and $K_{\perp}-K_{\parallel}$ for Ni^{++} ion, (3) An appreciable departure from the theoretical linearity law is found for the temperature variation of the anisotropy of the Cu^{++} ion in all the Cu^{++} salts, (4) In the Ni^{++} salts the observed experimental facts agree broadly with the theoretical law, $T(K_{\perp}-K_{\parallel})=AT+B+C/T$, but the constants A, B and C are functions of temperature, (5) The experimental curves for both Cu^{++} and Ni^{++} salts are different from salt to salt even in the same isomorphous series, (6) In Ni^{++} salts the spin orbit coupling comes to within ± 5 of the spectroscopic value $(-324\,Cm^{-1})$ for the free Ni^{++} ion, proving conclusively that 20 per cent lower value obtained from the resonance method is due to the inclusion of 'covalency factor' in the spin orbit coupling.

6. S. K. DUTTA ROY (Calcutta) : *Recent Magnetic interest of a number of Paramagnetic alums of the Iron Group.*

Measurements of the magnetic properties of a number of paramagnetic alums, whose importance in producing extreme low temperatures are quite well known, have been reported in this paper. The spectroscopic, dielectric, resonance and susceptibility behaviours of these paramagnetic alums of the iron group have been discussed in the light of the present observations. It has been shown further that there are two co-existing phases of the α, β and γ alums and thermal conversion from one phase to another occurs which consequently changes the crystalline electric field acting on the paramagnetic ion. Attempts have also been made to correlate the experimental results with the existing theories of Van Vleck, Penney and Schlapp, Siegert, Pryce and others.

7. A. K. DUTTA (Calcutta) : *A suitable Electric Picture of Graphite in Relation to its Abnormal Diamagnetism.*

The abnormal diamagnetic anisotropy exhibited by the well known hexagonal layer latticed crystal of graphite, which has been extensively measured here over wide ranges of temperatures, both high and low, is generally attributed to the presence of free electrons in graphite lattice. In order to ascertain the origin of these electrons, various pictures have been presented by different workers. But as will be evident from the discussions of the present note, none of the picture proposed is suitable for the purpose. An attempt has, therefore, been made in the present paper to postulate a suitable electronic picture of graphite which will not only explain the diamagnetic anomalies but will also be suitable for explaining the electrical and other electronic properties of graphite.

8. BHAGAWATI CHARAN GUHA (Calcutta) : *Paramagnetism of Copper Salts.* The magnetic behaviour of cupric salts exhibits interesting features.

In the ordinary sulphate and Tutton salts the square of the mean magnetic moments falls on the average from 3·7 at room temperature to 3·6 at 80°K, in the double halide from 3·6 to 3·2, but in the acetate from 2·1 to 0·22. Since the Cu++ ion is in the ^2D state, the spin-only value for the square of the magnetic moment is 3. Obviously the orbital contribution is not negligible in the sulphate, double sulphates and double selenates, or in other words the crystalline electric field in the neighbourhood of the paramagnetic ion will be cubic in character with a feeble non-cubic part superimposed on it. In the double chloride the structure suggests a stronger non-cubic component to the crystalline field which in effect lowers the magnetic moments. In the cupric acetate, however, the susceptibility passes through a maximum at about room temperature and then decreases so rapidly that it would apparently fall to zero at about 50°K. Since the paramagnetic ion here is not covalently coordinated with its neighbours, the only plausible explanation of the anomalous magnetic behaviour it seems, is due to the shortening of Cu-Cu distance which would give rise to strong exchange forces. This is exactly what has been found recently by the X-ray analysis of its structure. Here the distance between the two ions of a pair is only 2·64Å, whereas in the sulphate and others the distance is about 4·64Å.

Considerable interest has been shown by a number of workers in the U.S.A., Great Britain and Japan in the extraordinary behaviour of copper acetate and studying its paramagnetic resonance spectra at different wavelengths they arrive at the same conclusion as ours. Anomalous paramagnetic resonance has been found also in copper propionate.

9. **ATMA RAM, S. KUMAR and PRABHU NATH** (Calcutta) : *Magnetic Studies on Glasses Containing Manganese.*

During recent years, a considerable amount of work was done on magnetic properties of glasses containing paramagnetic colouring compounds, in order to identify the different states in which they are present in glass.

Spectro-chemical studies indicate that manganese can be present in glass in various states of oxidation, each state having its own characteristic colouring properties. In comparatively acidic glasses, however, manganese is known to be present in two forms, one is pink and the other almost colourless.

With a view to studying the nature of the different forms of this important colouring ingredient, magnetic susceptibility of different types of glasses containing manganese were measured with Gouy balance and the paramagnetic moment of Mn (μ Mn) was calculated. The results indicate that—

(1) The value of μ Mn in glass being in between those of μ Mn++ and μ Mn+++ (5·9 and 4·9 Bohr magnetons respectively) manganese was present in these two ionic states and probably not as oxides.

(2) The higher the melting temperature, the larger was the extent of dissociation of Mn+++ to Mn++ and hence, higher the μ Mn. This necessitated the use of special types of low melting glass for the present study of the oxidation reduction equilibrium.

(3) In the same type of glass the pink colour due to manganese was more when μ Mn was low and therefore °Mn+++ was higher. While the pink colour was due to Mn+++ ion, the colourless form was due to Mn++ ion.

(4) The nature and intensity of this pink colour of Mn+++ changed considerably, however, with changing composition of the base glass. Thus, when magnetic measurements on some of the glasses indicated the presence of Mn+++ only in traces they were still deep pink in colour.

Specific extinction co-efficient of Mn+++ as calculated from the spectrophotometric and magnetic data was found to be extremely high in certain glasses and this was tried to be interpreted on structural basis.

I. EXPERIMENTAL MORPHOLOGY

Section of Botany

Chairman : PROF. S. N. DAS-GUPTA (Lucknow).

Dr. T. S. Mahabale (Poona) opened the discussion.

1. DR. T. S. MAHABALE (Poona) : *Leaf Buds in Ferns.*

Vegetative propagation by means of buds variously formed is not uncommon in ferns. It is known in about 40 genera and 200 species. Some of these buds arise from roots, some from tip of leaf or parts of it such as rachis and lamina, some from the soral cushions and some from prothalli. A systematic study of these buds is being made in this laboratory and an account of the leaf buds studied in some ferns is given below.

Leaf buds are found on primary leaves of many ferns; on the rachis on which they arise anywhere from the base to the tip. Origin of such buds has not been studied in many cases but generally they are considered to be of epidermal origin. From the recent work of Prof. Wardlaw (1946-1952), however, it appears that they could arise from tissues below epidermis. Most of the earlier authors such as Reinhold (1926), Beyerele (1932), McVeigh (1934, 1937), found that the origin of such buds is from the unspecialised cells either at the tip of leaf or from the epidermal cells. Such was found to be the case particularly in *Ceratopteris thalic-*

troides Linn., *Gymnopteris subcrenata* Hook & Grev., *Adiantum caudatum* Linn., *Adiantum lunulatum* Burm., *Goniopteris prolifera* Roxb. and *Asplenium rutaefolium* Kunze.

A careful study of the position of such vegetative buds in ferns shows that it is very variable. In *Davallia canariensis* (L) Sm., *Nephrolepis biserrata* (Sm.) Schott. it is from the basal part of the leaves, whereas, in *Helminthostachys zeylanica* Linn. and *Botrychium lunaria* Linn. it is from the leaf axil. It arises from any part of the whole leaf surface in *Ceratopteris thalictroides* Linn. as in *Polypodium* aureum Linn. In *Angiopteris evecta* Hoffm. and in the seedlings of *Osmunda regalis* Linn. it arises from the stipules and swollen leaf bases of young sporophylls respectively. In stoleniferous species of *Adiantum*, *Gymnopteris flagellifera* Wall., *Gymnopteris contaminans* Wall., and *Gymnopteris subcrenata* Hook & Grev. they arise from the tips of leaves. They occupy a unique position in *Hemionitis arifolia* Burm. in the midst of the sinus of leaf lobes. A careful consideration of their position in these and other ferns shows that they have gradually shifted from extreme apex of the frond towards the axillary position, which possibly affords advantages in respect of nutrition and protection. From their extreme terminal position at the leaf tip in *Adiantum*, they lie anywhere on the expanded lamina in *Ceratopteris*, *Goniopteris* and in species of *Gymnopteris*, till they come to lie nearly to the base of the leaf in *Cystopteris bulbifera* (Linn) Benth. *Asplenium bulbiferum* Forst., *Hemionitis arifolia* Burm, and in the axil of leaf in *Angiopteris*, *Botrychium* and *Helminthostachys*. Whether this shifting of the buds in these ferns is correlated with the concentration of some phytohormone is a point worth investigating and is being studied in this laboratory.

The following took part in the discussion that followed Dr. Mahabale's observations on '*Leaf buds in ferns*' :

Dr. S. NARAYAN SWAMI (Delhi) : My opinion was that IAA causes in general, cell elongation and indirectly might influence the formation of buds. It is quite possible that in very low concentrations, IAA would appear to promote bud formation.

Dr. N. DAS (Gauhati) :

1. No auxins at any concentrations are found to stimulate the bud growth. It is still hypothetical that IAA stimulates growth at certain concentrations. Extensive investigations must be carried out to prove Prof. Mahabale's contention that IAA stimulates the growth of the buds of fern.

2. The stimulation of excised root sections is caused by 10^{-5}, 10^{-6} P.M. of concentrations at early hours. (Cf. Paper by Audus and Das—Journal of Experimental Botany, 1955).

Dr. S. P. SEN (Calcutta) : While talking of the effects of Indole acetic acid insofar as promotion or inhibition is concerned one should remember that apart from concentration ratios, the type of tissues and the source of such tissues are of considerable importance. A classical example is the pea root where growth is promoted by auxins though auxins usually inhibit root growth.

Dr. T. M. DAS (Calcutta) : I have noticed that when IAA at 10^{-8} to 10^{-4} is applied to the excised root of rye there is a promotion of growth but such concentrations inhibit root growth when roots are attached to the endosperm which indicates that factors present in the endosperm also take part in auxin action. I consider that other factors with IAA possibly have taken part in promotion of bud growth in fern.

Dr. Mahabale, in reply to a question by Dr. B. Samantarai, said that IAA applied in small doses less than 0·1% does promote growth in buds depending upon the method of application. It is difficult to say exactly how much quantity of this or other substances when applied is absorbed except by the effect it produces. He also said that mere elongation of cells should not be considered as the entire morphogenetic effect. The action of this as well as many growth promoting substances on buds and excised fern leaf axils is really very complex. Dr. Mahabale also discussed the points raised by other speakers.

2. B. SAMANTARAI and T. KABI (Cuttack) : *Experimental evidences on 'the partial shoot theory of the leaf'.*

Arber (1950) has discussed in detail 'the partial shoot theory of the leaf' in her book 'The Natural Philosophy of Plant Form'. She has cited a large number of examples in support of this theory. We have come across certain experimental results, which lend further support to this theory.

(1) *Root formation*—The production of roots from leaves as in stem cuttings is one of such evidences.

(a) *External character*—Attached leaves do not produce roots, but when isolated and treated with aqueous solutions of hormones produce copious roots. Sometimes the detached leaves produce roots without any treatment. Gregory and Samantarai (1950) have found root formation in the detached leaves of ivy and French bean when the leaves were treated with hormone. Misra and Samantarai (1953) and Samantarai and Kabi (1954a) have reported similar results in a number of tropical leaves. It has also been observed in some cases (*Ipomoea*, *Chenopodium*, *Pogostemon* etc.) that the roots develop even from the midrib and lateral veins. Externally these induced roots resemble the adventitious roots originating from stems.

(b) *Functions of the induced roots*—The functions of these induced roots are similar to those of the normal or adventitious roots. Buds are also formed from the induced roots of the leaves of *Ipomoea batatas* just in the manner they originate from the tuberous roots of the stem; hence the roots serve as a means of reproduction as well.

(c) *Endogenous origin of the induced roots*—The origin of the roots in the leaves is endogenous just like those developed from the stem. Gregory and Samantarai (1950) found that the initiation of the root primordium, in case of the leaves of ivy and French bean, takes place just at the back of the vascular bundles of the petioles. At first the parenchymatous cells lying external to the phloem become meristematic and later on become organised to form the root primodium. This region corresponds to the pericycle of the stem. Similar results have also been obtained by Samantarai and Kabi (1954b) in the leaves of *Chenopodium album*. The root primordium gradually grows outwards penetrating through the cortical cells and emerges out. Tissue differentiation in these growing roots takes place as in the typical adventitious roots and finally the xylem and phloem become connected with the xylem and phloem of the petiole.

(2) *Bud formation*—Regeneration capacity in forming buds like some stems is one of the evidences regarding the stem nature of the leaf. It has been observed in the leaves of *Ipomoea batatas*, *Sanseviera zeylanica*, *Tagetes patula*, *Heliotropium indicum*, Cabbage and others that when the rooted leaves are grown in soil they produce buds. These adventitious buds are just like the buds developed in the axillary region. The origin of these buds is also exogenous like the normal buds developing from the stem. A few cells become meristematic in the cortical region of the petiole and they become organised to form a shoot apex. The structure of this shoot apex is like the normal shoot apex. There is a distinct tunica-corpus organisation and the buds grow out piercing through the cortical cells. Later on, vascular connection is established between the growing bud and the petiole.

(3) *Secondary growth in the petioles*—The manifestation of secondary growth in the petioles as in stems strongly supports the partial shoot theory of the leaf. It has been observed that generally secondary growth does not take place in the

petioles of the herbaceous dicot leaves when they are attached to the stem. Detached leaves, treated with hormone, along with root production show a good deal of secondary growth. Cambium is very rudimentary in the vascular bundles of the petioles of the leaves. A few days after treatment with hormone, cambial activation starts and when the rooted leaf is grown in soil profuse secondary growth takes place. A number of such cases have been observed in the petioles of herbaceous leaves with different vascular arrangements (Samantarai and Kabi, 1954b; Misra and Samantarai, 1955).

In the leaves of *Chenopodium album* the vascular bundles are arranged in the form of a ring with two discrete bundles towards the adaxial side. The cambium in the vascular bundles is either absent or rudimentary. Activation of cambium in these vascular bundles is observed few days after hormone treatment. When the rooted leaves are grown in soil secondary growth is observed from the fascicular cambium. Accessory cambium ring is also developed around the phloem and secondary vascular tissues and conjunctive tissues are developed from this cambium. This type of abnormal secondary growth resembles the type found in the stem of the same species. In *Amaranthus gangeticus* secondary growth is observed in the petioles of the rooted leaves resembling very much with the secondary growth found in the stem of the same species.

The petioles of *Cephalandra indica* possess bicollateral vascular bundles and the bundles are arranged more or less in the form of a ring. The bicollateral vascular bundles of the stem show profuse secondary growth restricted to the fascicular cambium only. The rooted leaves of this species produce secondary growth which is just like the type of secondary growth found in the stem.

In many other herbaceous leaves like *Ipomoea batatas* and *Pogostemon plectranthoides* secondary growth has been observed in the petioles of the rooted leaves resembling the type seen in their respective stems.

The leaves of woody plants show secondary growth in their petioles and main veins even when attached to the stem. It has been observed by the authors (1957) that the leaves of *Schleichera trijuga, Ficus religiosa, Tectona grandis,* etc. possess strong petioles and the laminae are large. In the young leaves the cambium is rudimentary but along with the growth of the leaf, cambial initiation takes place and secondary growth occurs. In case of *Schleichera* the petioles of the leaflets also show secondary growth. In the simple leaves of *Tectona* and *Ficus* the midribs possess secondary growth. In *Argyreia* although secondary growth takes place in the petiole when the leaf is attached to the plant, the pattern is not the same as seen in the stem. When these leaves are treated with hormone the secondary growth which is formed is of the type found in a mature stem (1957).

(4) *Self maintenance*—Self maintenance of the leaf as an independent unit like the stem is another evidence of the stem nature of the leaf. The hormone treated isolated leaves lead an independent existence by the help of their induced root system. It has also been observed by Gregory and Samantarai (1950) that the rooted leaves of ivy when grown in soil lived for a pretty long time and much longer than the attached leaves. They have observed very little growth in these leaves. Work done in this laboratory shows similar results but in a few leaves like *Basella* (1956) the lamina expanded much more than that on the stem.

The longevity of these rooted leaves is always more than the attached leaves of the same age. The rooted leaves of ivy live for a longer period than the attached leaves, so also the others.

To sum up, the production of roots from the isolated leaves, the endogenous origin of these roots, the formation of buds from the petioles of isolated rooted leaves, the production of secondary growth in such leaves and the increased longevity of the leaf together with the capacity for expansion of the lamina in some cases, clearly lend further support to 'the partial shoot theory of the leaf'.

The following took part in the discussion that followed Dr. Samantarai's Observations on *"Further evidence on the partial shoot theory of the leaf"* :

Dr. N. DAS (Gauhati).

1. Did you use C.B.A. and sugar because sugars, it is said, act as a co-factor in promoting root growth ?

2. In his experiment he should use any other antiauxins other than maleic hydrazide which is always a growth inhibitor and see if actually the so-called antiauxins suppress the stimulation of auxin action in the promotion of growth in roots.

Dr. SATISH CHANDRA GUPTA (Nainital) : It was added that in the studies with the detached leaves floated on distilled water, leaves of *Urtica dioica* showed very poor sectional growth in comparison to the sectional growth showed by Dr. Samantarai. Secondly the sectional growth in these petioles was different from the sectional growth of the stem of the same plant while Dr. Samantarai observed identical sectional growth in the detached leaves and stems.

Dr. T. S. Mahabale (Poona) and Dr. T. M. Das (Calcutta) also took part in the discussion. Dr. Samantarai discussed the questions raised by various speakers.

3. DR. S. NARAYANA SWAMI (Delhi) : *Experimental studies on gemmae of the liverwort Lunularia.*

The gemmae of the liverwort *Lunularia cruciata* lend themselves admirably to studies in experimental morphology. They are very sensitive to treatments of various kinds and responded by branching in a most unusual manner. The new type of branching took place at right angles to the usual direction of branching. This resulted in the formation of two lobes at the tip of the thallus with one above the other so as to produce a double-decker effect or 'splitting'. This phenomenon was observed in treatments with a number of diverse chemicals. Splitting has also been induced by plasmolysis, mutilation and irradiation by ultraviolet rays and gamma rays from a cobalt 60 source. It is suggested that any factor which could temporarily inhibit the elongation of the young thallus tip might cause a thickening of the tip and consequently set up the mechanism for splitting.

The outgrowths from treated gemmae showed strange and unusual morphological divergences from normal development. Each chemical produced a characteristic morphological type different from all others. The morphogenetic influences of various physical factors on the growth pattern of gemmae were also studied. The agents employed were centrifugation, slicing, perforation, excision of growing parts, abrading of surfaces, exposure to oxygen, nitrogen and carbon dioxide hydrogen-ion concentration etc. No permanent effects were provided by the various treatments. An attempt has been made to explain the abnormal morphological variations on the general basis of injury, inhibition and removal of apical dominance.

In the course of the above investigations, the curious phenomenon of apical dominance so well exemplified by the higher plants, was indicated. Normally the gemmae of the liverworts do not germinate within the gemma cup unless they have been detached from the parent body, nor are adventitious buds formed on normal thalli. Mutilations such as puncturing, slitting, excision of wings etc., did not show any effect on the gemmae so long as the apical notches and the midrib regions were in tact. This indicated the action of auxin inhibitors. The upper halves of thalli isolated by transverse cuts do not regenerate adventitious buds whereas the basal halves do so from the cut ends. Applications of growth hormones to the cut ends confirmed the inhibiting influence of the apical notch. Positive results for the formation of auxin have been obtained with *Avena* tests of the extracts of thallus tips. Preliminary experiments with analysis of such extracts by paper chromatography suggest that the auxin involved may be indole acetic acid.

Dr. B. Samantarai (Cuttack) and Dr. R. N. Singh (Banaras) took part in the discussion that followed Dr. Narayana Swami's observations on "Experimental studies on gemmae of the liverwort Lunularia".

4. **Dr. H. L. Chakravarty** (Calcutta): *Experimental Morphology: How it helps in dtetermining the real structure of the Stamens in Cucurbitaceae.*

The morphology of the androecium of Cucurbitaceae remained a debatable problem for decades. Arguments were advanced from time to time to elucidate its structural peculiarities. In the cultivated cucurbits like *Lagenaria, Luffa, Trichosanthes, Benincasa, Cucurbita, Citrullus, Cucumis Momordica* etc. as well as in wild genera like *Edgaria, Herpetospermum, Bryonia, Bryonopsis, Hodgsonia* etc. there are three stamens of which two are bithecious and one monothecious with anthers variously convoluted. In the wild genera like *Fevillea, Alsomitra, Neoalsomitra, Zanonia, Hemsleya, Thladiantha, Actinostemma,* etc. on the other hand, the stamens are five in number each free from one another and anthers erect or curved but not convoluted. The author has shown (New Phytol. 1949, *48*, 448-452 ; Sc. & Cult. 1949, *15*, 121-22; Bull. Bot. Soc. Beng., 1951, *5*, 31-50; ibid, 1952, *6*, 53-56; ibid, 1954, *8*, 186-215) that these five free staminate-flowered genera of Cucurbitaceae are the ancestors of present day cultivated species with three stamens. The present day cultivated cucurbits in the course of evolution gradually lost their bithecious nature of stamens by progressive sterilization of one arm of the dichotomous bundle formed at the distal end of the filament supplying the two theca on either side of the anther and resulted in five monothecal stamens. Then by gradual cohesion of the adjacent stamens two bithecal stamens and one monothecal stamens are produced. The presence of two vascular bundles in the two bithecious stamens and the presence of a single vascular bundle in the monothecious one in the three staminate flowers clearly shows that the two bithecal stamens are produced by complete amalgamation of two monothecious stamens. The odd stamen having one theca and a single bundle remained undisturbed in the union process. Hence the bithecal stamens having two vascular bundles are homologous to a compound stamen and analogous to an ordinary tetrasporangiate stamen.

The parental stock of Cucurbitaceae had five stamens which are all bithecal. In some genera like *Coccinia* some flowers yet show five bithecal stamens free from one another and each having a single vascular bundle. Five free bithecious stamens are found in *Anisosperma* a Brazilian genus. South America may be regarded as the original home of Cucurbitaceae as here quite a large number of genera are wild and all possess five stamens.

In the end, the Chairman summarised the contributions made by the various speakers and pointed out that Experimental Morphology offers a rich and fruitful field for further research.

II. THE BOTANICAL ASPECTS OF ANTIBIOTICS

Chairman: **Prof. S. N. Das-Gupta** (Lucknow).

1. **Prof. T. S. SADASIVAN** (Madras) opened the discussion:

It gives me immense pleasure to be here today to enjoy the honour of opening this symposium. Before I do so, I record my thanks and appreciation to our President, Professor S. N. Das-Gupta for his kindness in inviting me to take part in this symposium.

It was not till the discovery by Brian *et al.* (1951) that the Plant Pathologists seriously considered that there is a possibility of antibiotics produced in the soil being detected in the guttation fluids of plants following a systemic spread through plant tissues. This fundamental approach to vivotoxins naturally brought into its orbit many hitherto unexplained observations and the result was an intense physiological approach to understanding these problems of host/parasite interactions. For instance, Brown's (1934, 1936, 1955) theories of enzyme-substrate interaction had been more steadily adhered to by recent workers and, indeed, the production of the twin enzyme systems by root-infecting fungal pathogens, the pectin methyl esterase (PME) and pectin galacturonase (PG), has been effectively and energetically screened, and the importance of heavy metals as bio-catalysts of enzyme action has been given the status it deserves, particularly in view of the complementary nature of these metals in the absorption and utilization of vitamins of the B-group by vitamin heterotrophic organisms (Apparao *et al.*, 1955). Further, the important findings that sequestrene compounds and organic chelating agents like 8-hydroxyquinoline and ethylene diamine tetra-acetic acid (EDTA) are of importance in *in vivo* chelation of metals in plants have added yet another fruitous line of investigation for Plant Pathologists as they hold great deal of promise in the matter of withdrawal of heavy metals *in vivo* aimed at inactivating the fungal toxin such as fusaric acid. In other words, it is now within the limits of feasibility that the potentiating effect of heavy metals on toxins could partially, if not wholly, be nullified by the judicious application of chelating agents.

Against this background of theoretical possibilities, I wish to present some of our results that appear relevant to this symposium. One of the main problems has been the development of methods of detecting the onset of toxaemia. Subba-Rao (1954) examined cotton seedlings infected by *F. vasinfectum* under ultra-violet light (3655 A) and found that there was characteristic fluorescence of stems and veins of leaves and that aqueous extracts of infected cotton plants exhibited fluorescence *in vitro* similar to that of dialysed culture filtrate of the pathogen responsible for the wilt of cotton. Transactions of infected stems also revealed characteristic fluorescence of the vascular region only. This simple physical method, therefore, appears to be an useful screening technique and can, probably, with suitable modifications be extended to the routine study of toxaemia produced by vivotoxins.

The quantitative detection of vivotoxins from plant tissues has been a vexed problem. Two methods of approach have been made by our investigators, firstly, the chromatographic method by simple chelation of fusaric acid as a copper complex and then intensifying the band with ammonia vapour (Lakshminarayanan and Subramanian, 1955), and secondly, by a chromatographic cum bioassay technique (Kalyanasundaram and Venkata Ram, 1956) by planting dried chromatograms containing fusaric acid on bacterial seeded agar and the Rf value determined in the usual manner. More recently Subba-Rao (1957) has detected quantitatively gibberellic acid from infected rice plants by circular paper chromatography as a silver compound and then intensifying the band with ammonia vapour. This method has advantages over the bioassay techniques for the detection of gibberellic acid by observing elongation of plant stems.

Turning to the plant itself, the facility with which toxaemia is induced appears to depend largely on the sum total of the substrates available for the development of the enzyme systems of the fungus. For instance, in the cotton plant, the tetraploid resistant varieties of Cambodia (C2) and Madras Uganda (MU1) (hirsutums) and the diploid susceptible K2 variety (arboreum) have basic differences in their ability to synthesize and accumulate non-protein nitrogen (NPN) and during infection in the susceptible variety the NPN levels decline, whereas the protein nitrogen levels (PN) remain constant (Satyanarayana, 1955). The resistant varieties accumulate organic nitrogen mostly as proteins and this appears to be one of the general patterns associated with resistance. It is possible that the shoots of the susceptible varieties lose their NPN in the infected state permitting the formation of the toxic polypeptide during pathogenesis. In other words, the pathogen is unable to utilize the protein substrate available in the resistant variety. It has to be emphasized here that in the cotton it is not only extremely difficult to classify and grade susceptibility or resistance, (as the normal methods of production of hypersensitivity reaction as a gradable syndrome, are either totally absent in a systemic infection like the wilt toxin, or if present is not easily detectable) but also it would seem premature and hazardous to overdraw conclusions based on a single criterion or a few criteria like PN and NPN syntheses or for that matter the pectin substrates. It is, nevertheless, open to one to hypothesize, and to some extent speculate, on the possibilities of some interacting factors which singly or collectively bring to bear circumstantial evidences on the basic question of toxaemia and its initiation. One such factor of substrates is pectin which appears to be readily available in sizeable quantities in the roots of the susceptible cotton variety K2 and is present only in much less quantities in those of the resistant plants. Elsewhere, (Sadasivan, 1957) the role of heavy metals in bringing about an inhibition or activation of enzymes by the formation of metallo-substrates (as metallo-proteins) has been discussed. For purposes of comparison here, it would suffice to point out the interesting role of zinc in activating methyl esterase activity in *F. vasinfectum* inoculated roots of cotton plants at low levels, followed by a steep decline at 50 p.p.m. and above. Indeed, one of the main changes in tissue respiration brought about by toxaemia is an increased tissue respiration indicating the availability of more energy substrate for respiration. Chelating agents depress this respiratory activity, whereas heavy metals could nullify the effect (Lakshmanan, 1955). Zinc has also been shown to potentiate fusaric acid output *in vitro* in low concentrations, whereas higher concentrations inhibit it, a fact of considerable importance when considering the role of these heavy metals in the formation of metallo-proteins and their dissolution *in vivo* (Kalyanasundaram and Saraswathi-Devi, 1955).

An interesting evidence highlighting the above findings on energy substrates and *in vivo* toxaemia has just been published (Kalyanasundaram and Subba-Rao, 1957). With the onset of toxaemia (*F. vasinfectum* infected cotton seedlings) in a thermostatistically controlled miniature glasshouse, at the air temperature of 32·5°C., fusaric acid content as mg./100 g. fresh weight of plant was one-fourth that at 37·5°C., yet at 37·5°C. the wilt index was only one-fifth of that at 32·5°C. Similarly, appearance of cystine at 37·5°C., was much higher than at 32·5°C., a fact that seems to offer an explanation to the strong chelating influence of this amino acid with metals like Fe^{III} thus rendering them unavailable for potentiation of fusaric acid. These authors sum up the position by stating: "An understanding of the quality of bound and free metallic ions available in the host at varying temperatures of incubation and the enzyme studies of the host as well is bound to throw light on this problem." It may be pertinent to speculate here that the possibility of ascertaining by paper chromatography if Fe-cystine chelate would move with the same rapidity on paper as either of them alone should not be ruled out and if this proved, (as in the case of fusaric acid-copper complex, the Fe-cystine complex may have different ionization over Fe or cysteine, recordable on a chromatogram) it may be a convenient quantitative method of determining the bound state in which the Fe-cystine exists in tissues of plants showing a recovery of symptoms at 37·5°C.

Before I wind up, I would like to discuss a few problems arising out of spectrochemical ash analyses of cotton seedlings using the Lundergardh Flame Photometry. With the onset of toxaemia, susceptible cotton plants show a primary loss in permeability of the key metabolite potassium and an accumulation of varying quantities of Mg, Ca, Fe, and Mn, the last mentioned element showing very considerable mobility over the healthy control (Sadasivam and Kalyanasundaram, 1956). Viewing this against the critical conductivity measurements made by Gnanam (1956) wherein she indicated a higher accumulation of electrolytes in the diseased plants over the healthy, the net effect as a consequence of deranged semi-permeafility is the almost total disappearance of the element K, as much larger uptake of Mn and a net gain over the healthy plant in electrolyte mobility and accumulation. A more recent contribution to this subject (Sadasivan and Saraswathi-Devi, 1957) shows that the basic question of electrolytes and their mobility in resistant cotton plants (Cambodia) as against the susceptible (K2) is that, while the K2 takes up much more of K than the resistant, the presence of the pathogen in the soil brings about a remarkable fall in K mobility in the former, as is to be expected, and an equally surprising diminution in the uptake even in the resistant variety, a fact that has to be reconciled by further study of other genetic varieties. There appears some reason to feel optimistic in that K-absorption, and as a matter of that, the pattern of absorption of other ions may be gene-controlled, a fact if proved conclusively, could have great bearing on understanding *in vivo* chelation in toxaemia. This would then present a rationale in judicious selection of parents for future hybridization programmes aimed at evolving resistant varieties to combat the difficult problem of vivotoxins and wilt production.

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3. **Dr. G. RANGASWAMI** (Coimbatore) : *Importance of Antibiotics in Plant Disease Control.*

Introduction : The discovery and utilization of antibiotic substances in medicine has so much revolutionized the science that the present period is considered by most physicians and microbiologists as the 'antibiotic age'. Though the phenomenon of antibiosis was known to the very early microbiologists like Louis Pasteur, John Tyndall, and Anton de Bary, the chemical nature of the phenomenon was understood only recently. The isolation of gramicidine, a polypeptide antibiotic, from *Bacillus brevis* Migula emend. Ford by Duzos in 1939 (3) and the rediscovery of penicillin by Florey and his associates in 1940 (1) firmly established the new branch of science. The tremendous amount of success attained in the use of antibiotics in medicine gave impetus for intense research on their use in different fields of science. Several antibiotics have been tested against fungal, bacterial, and virus diseases of plants during the past seven or eight years and a good amount of valuable information on the subject is available. It is my purpose here to bring out in brief the important need for the use of antibiotics in plant disease control.

The Need for Systemic Agents in Plant Disease Control: Great economic losses are known to be caused by various plant pathogenic fungi, bacteria, and viruses. The method of controlling the diseases caused by these pathogens depends upon the nature of the disease and the amount of damage caused. Probably the best method of combating any disease is to grow resistant varieties, but it is not always possible to obtain varieties resistant to various diseases of a crop plant. The genetic factors controlling the resistance to different diseases and the economic qualities in a crop variety may not always be the same. Some of the foliar diseases caused by fungi, however, are easily controlled by protective sprays with effective fungicides, whereas internal infections, systemic diseases, and root diseases like wilts and root-rots, are very difficult to check. Internal seed-borne infections are often difficult to eradicate except by heat treatment which involves certain amount of risk. The bacterial cells enter the host plant through natural openings and wounds and the infection period is very short as compared to that of fungal infections. As such ordinary methods of protective spraying practised for fungal diseases are not quite effective for bacterial diseases. Besides, it is not always possible to leave an absolute protective layer of a bactericide on a growing plant. When once the pathogen enters the host plant any amount of external spraying with ordinary antibacterial agents will not be of much use. The same thing can be said for the virus infections. The systemic nature of most of the virus diseases makes it more difficult to deal with.

It is needless to say, therefore, that a chemical agent which, when present inside the tissues, can prevent the inset and spread of the disease is the most ideal substance for combating the difficult fungal, bacterial, and virus diseases of plants mentioned earlier. Such a chemical should be easily administered, preferably by foliar sprays, readily absorbed by the tissues, and transmitted systemically, so as to make the treatment culturally and economically feasible.

Antibiotics and their properties : Antibiotic substances are known to be produced by several strains of bacteria, actinomycetes, and fungi. More than three hundred antibiotics have already been isolated from these organisms and there is an ever increasing flow of new substances being reported in the literature. Most of these antibiotics possess primarily antibacterial properties, some primarily antifungal, and a few have antiviral properties. Most antibiotics are inhibitory to only a small group of organisms, whereas a few are effective against a wide range of microbial species and are known as 'broad spectrum' antibiotics. The physical and chemical properties of antibiotics vary very widely. Some are readily soluble in water while the others are only sparingly soluble in most organic solvents. The basic and polypeptide antibiotics are highly thermostable while the others like penicillin are labile even at room temperature. In general the antibiotics are stable to light, but some like filipin are inactivated by short exposure to light. The molecular size of the antibiotics may also vary a great extent. Chemically antibiotics are classified as basic, polypeptide, quinone, polyene or neutral substances. As in any other chemical the presence of various active groups in the molecule like hydroxyl, carboxyl, amino, nitro, thio etc. groups, peptide linkages, unsaturation etc., define the chemical activity of an antibiotic.

Evaluation of Antibiotics for use in Plants : Large scale screening of chemical substances for chemotherapeutic properties in plants has been carried out in recent years and a few have been reported to be effective (8). With the availability in the market of the antibiotics the work on the study of the *in vitro* and *in vivo* effect of these agents on plant pathogenic bacteria and fungi started. Several known and newly isolated substances have since been evaluated for this purpose. The uptake, systemic translocation, and regional concentration of the antibiotics in plants have been studied in detail (2, 4, 5, 9). The results obtained so far go to show that antibiotics are the most promising systemic agents for controlling plant diseases. The possible mode of action of antibiotics in the control of plant diseases has been discussed by Pramer *et al* (6).

The antibiotics of fungal origin like penicillin, clavacin, patulin, penitalin, griscofulvin, gliotoxin, etc. have been reported to check certain bacterial or fungal infections of plants. The foremost of all these, penicillin, was extensively studied for this purpose but has not come into use mainly because of its low activity against plant pathogenic bacteria and also because of its thermolabile nature.

Of the several actinomycete antibiotics studied for controlling bacterial diseases of plants streptomycin has emerged as the best and has come into wide use in the United States of America. Chlortetracycline (aureomycin), oxytetracycline (terramycin), chloramphenicol (chloromycetin), mycetin, neomycin, etc. have been reported to possess varying degrees of activity against bacterial infections of plants. Among the antifungal antibiotics of actinomycete origin, cyclohexamide (actidione), helixin, antimycin, thiolutin, musarin, etc., appear to be promising. Cycloheximide has come into use against fungal diseases of golf courses in the United States. Streptomycin has also been reported to possess *in vivo* activity against phycomycetous infections of plants. Mycothricin, an antibiotic related to streptomycin, has been found to be inhibitory to both plant pathogenic bacteria and fungi (10). Streptothricin, oxytetracycline, and noformin have been reported to possess some inhibitory effect on plant viruses.

The antibiotics of bacterial origin, especially subtilin, antibiotic XG, gramicidin, and pyocyanin have been evaluated for antifungal property but have not come into use as they are not readily transmitted systematically in plants and are also phytotoxic. An antibiotic preparation obtained from *B. subtilis* Cohn emend. Prazmowski has been reported to have antiviral properties *in vitro* (7).

Discussion : The urgent need for a systemic agent to control difficult plant pathological problems has been well felt by every one in the field. The studies made so far on the possibilities of using antibiotics for this purpose have given very encouraging results. Of the several antibiotics studied only streptomycin has come into use. The main considerations for the successful use of an antibiotic in plant disease control may be summarised as follows :

1. Non-toxicity of the antibiotic to plants at concentrations fairly higher than the inhibitory concentrations for the pathogens.
2. Water-solubility, ready absorption by foliar tissues, and systemic translocation in plants.
3. Stability to heat and light.

4. Persistence of the antibiotic in plant tissues.
5. Non-toxicity to man and animal.
6. Low cost of the antibiotic.

Of the antibiotics studied so far only basic group of antibiotics, to which streptomycin belongs, seems to satisfy most of the above-mentioned qualities. Streptomycin is mainly an antibacterial agent but an antibiotic with strong antifungal effect is badly needed. Some members of the basic group, especially mycothricin and pleocidin, possess considerable amount of antifungal effect. These antibiotics, however, are reported to be toxic to animals. The potentialities of these substances for controlling some of the diseases of crop plants and internal seed-borne infections, where the toxicity to man is of less significance, are worth examining.

It was once considered that the high cost of antibiotic substances prohibit their use in agriculture. With the advances made in the research on the production capacity and fermentation of antibiotics the cost/gm of the antibiotics has been brought down considerably. Streptomycin, which was sold at Rs. 40-60/gm in 1946-47 is now available for less than a rupee per gm. Furthermore, the price of the antibiotics available for medical purposes is made high because of the purification processes involved and the absolute aseptic conditions required while packing the substances. Since crude antibiotic preparations can be used for plant protection purposes without much bad effect the above two costly processes can be eliminated and the antibiotics made available at a considerably low price.

It is often argued that repeated use of antibiotics against a pathogen may result in the emergence of resistant and more virulent strains. This problem is applicable to most antimicrobial agents but in some cases, as in streptomycin against tubercle bacterium, the occurrence of resistant strains is relatively more common. To overcome these defects various combinations of antibiotics have been suggested and 'Agrimycin', a streptomycin-oxytetracycline mixture, and similar preparations have come into use. The screening of microorganisms for antibiotic production has so far been mainly directed towards pharmaceutical interests and the tests carried for use in plants were only secondary. More intense search with the above stated objectives in mind is likely to yield more effective antibiotics for use in plants.

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4. DR. B. K. BAKSHI (Dehra Dun) : *Aspects of biological control of wilt disease of shisam* (*Dalbergia sissoo* Roxb.).

Microbial control of the wilt of *shisham* caused by *Fusarium solani* was attempted in two ways : (1) to screen out the antagonists among the soil fungi active against *F. solani* and (2) to find out such weeds which possess antimicrobial activity against the pathogen *in vitro.*

1. 43 species of fungi isolated by dilution plate from different *shisham* soils, sick and healthy, and tested for their antagonistic properties against *F. solani,* gave negative results. It may thus be concluded that microbial control by soil amendments with a view to encourage the associated antagonists among the soil fungi is not possible in the control of wilt of *shisham.* This is due to the fact that *F. solani* is an ubiquitous soil saprophyte capable of intense saprophytic colonization. As such pathogens belonging to the soil inhabitant class, to which *F. solani* belongs, are less amenable to microbial control than the soil invader group, whose saprophytic survival is incidental to its parasitic existence.

2. Root extracts of herbaceous weeds that commonly occur in *shisham* forests were taken in distilled water and other solvents and tested separately against *F. solani.* Controls with solvents only were also set up. The results are given below :

Name of herb	Diameter (in mm.) of inhibition zone in solvents (diameter of cup 7 mm.)				
	Water	Ethyl alcohol	Ethyl ether	Acetone	Benzene
1. *Adhatoda vasica* Nees. ...	... —	20	14	11	11
2. *Murrava koenigii* Spreng.	... —	14	18	14	14
3. *Artimisia vulgaris* Linn.	... —	11	12	12	11
4. *Mimosa rubicaulis* Lam.	... —	12	17	12	—
5. *Dioscorea* sp. ...	... —	13	22	20	11
6. *Salvia pseudococcinea* Jacq.	... —	—	18	11	11
7. *Oplismenus compositus* Beauv.	... —	9	20	13	16
8. *Bidens pilosa* Linn. ...	... —	13	24	20	20
9. *Ageratum* sp. ...	... —	—	20	16	12
10. *Desmodium heterocarpum* DC.	... —	—	—	—	—

Discussion and Future Possibilities. The results indicate that root extracts with various organic solvents possess inhibitory effect on *F. solani in vitro.* Extracts in distilled water gave negative results. One pertinent question will arise in any attempt to translate the results in the field : Whether the plant roots will liberate the active principles into the soil in the living state. It may be however possible for the roots to release the active principles if the weeds are harvested regularly. In selecting the weeds, preference may be given to those which will yield a minor forest produce so that the method of raising them annually will be economically feasible in forestry practice. Another point that may be considered is whether the antibiotics released from the roots will be stable in the soil, at least for some time, since they can be inactivated by the soil complex or rapidly degraded or metabolised by members of soil population. All these factors need analysis before microbial control of soil borne pathogens by higher plants can be achieved in field.

5. DR. B. L. CHONA (New Delhi):

Dr. Chona briefly explained the work that is being carried out by Dr. R. S. Vasudeva and his colleagues and students for the last 8 or 10 years and stated that an antibiotic—Bulbomycin—has been isolated from a strain of *Bacillus subtilis*, which has antifungal and antiviral properties and can act as a systemic fungicide through soil under certain amended soil conditions. He further stressed the need of investigating such agricultural antibiotics for the control of plant diseases, that could work through soil and could be produced in the soil itself under natural conditions by the addition of some suitable nutrients to the soil.

6. DR. B. M. GUPTA (Lucknow):

Mr. Chairman, I have listened with good deal of interest to Dr. Rangaswami's suggestion in regard to the use of antibiotics to cure virus infection in plants. It is true that to be effective these substances should have specificity, low toxicity, water solubility, and be systemically located with the plant. However, the problem of specificity is not so simple. I would like to make few remarks on specificity of action that is required of an antiviral agent.

An ideal antibacterial agent need not necessarily possess antiviral activity. I should be surprised if a dual purpose agent will be found at this stage. Indeed the manner in which the virus is known to invade, multiply and spread from cell to cell leaves little room for doubt that the known antibacterial agents will be ineffective in curing plant already down with a systemic viral infection. However, much work, though not adequate, has been done on inhibition of virus infection in plants in last 10 years to warrant certain recommendation in regard to the way in which a potential antiviral substance should function.

Experience tells us that more ability to combine with virus in-vitro does not qualify a substance to be named antiviral, nor does it entitle it to be considered for use in the field. To be effective antiviral substance should not only be able to neutralise infectivity of a fully matured virus particle but its action should be much more specific, namely so alter the host cells of the foliar tissue that will lead to effective blocking of some subtle stage or step in the process of virus formation within the cell. Whether the two properties can be confined in one, I cannot say. Probably not. In either case, the success of an antiviral agent will depend not on its structure alone but also on the kind of host plant used. It is important to bear this at all times. Present evidence do not justify hope that a single antiviral agent will be found effective against a particular virus irrespective of the host it attacks, or on a particular host irrespective of virus parasitising it. A range of antiviral substances will have to be found for a single virus to protect as many host as are parasitised by it. Possibly biochemists and plant physiologists will get together to provide clues as to possible structure of such compounds.

Several microbial and plant products obtained during the last 10 years have been shown to possess antiviral activity in plants. They all tell practically the same story. They are effective when applied to leaves just prior to or at the time of inoculation. Their action depends upon the type of host plant and condition of host cells prevailing at the time of application. Their chemotherapeutic action is limited to very early stages of the infective process, and not later. It is obvious that these substances do not go deep enough; their action is very likely restricted to cell surface where they compete with virus particle for cell entry. It is possible that their inability to localise a virus infection may be due to their being ineffeciently translocated and distributed, the concentration reached being inadequate to give necessary protection to cells neighbouring the infected area.

7. **Dr. R. S. MATHUR** (Kanpur) :

The chief motive for discovery and production of modern antibiotics has been to combat human diseases. It is well known that the majority of human diseases are caused by bacteria which are inactivated by the modern antibiotics. In contrast the majority of plant diseases are caused by fungi and therefore the modern antibiotics should have very limited role in the control of plant diseases. Even for the treatment of human beings the cost of these modern antibiotics is often prohibitive hence the likelihood of a general application of modern antibiotics for preventing plant diseases appears to be very remote.

Nevertheless the importance of finding suitable fungal and plant alkaloids or chemical compounds to neutralise or inhibit the toxins produced by plant pathogens remains as urgent as ever. It is therefore suggested that work on the following lines may be undertaken even though the practical application of this work under field conditions may not appear very promising to start with :—

1. Saprophytic bacteria like *Bacillus subtilis* which have been known to inhibit the growth of many pathogenic fungi should be sprayed on plants before they receive a shower of spores of pathogenic fungi in nature, for instance if colonies of *Bacillus subtilis* are allowed to grow luxuriantly on plants without harming them, they may inhibit the growth of sooty molds, leaf smuts and other fungi like rusts and Phytophthora whose infection is established through stomata.

2. The antibiotic alkaloids contained in the roots and shoots of gymnospermic and angiospermic plants should be tested and isolated for antagonism against plant pathogens.

8. Rev. Dr. H. SANTAPAU (Bombay) : *Antibiotics from higher plants.*

In connection with antibiotic substances obtained from higher plants, much time and energy has been wasted in the past mostly for want of method in the research. The following points require careful attention :

1. The identity of the plant from which antibiotic material has been obtained should be fixed definitely, and this is to be done not merely by reference to indigenous or local names. Local names are often too vague, or apply to more than one plant.

2. The life cycle of the plant is to be studied in connection with best yield of the principles sought in it; as an example, *Ephedrine* was obtained in the past from several species of Ephedra; but the manufacturers found by experience that once plants had come into flower or fruit, it did not pay to extract Ephedrine from them.

3. The anatomy of the plant is to be studied; at times it may be possible to obtain the raw materials without destroying the plant. For. example : *Pristimera indica* and *grahamii* have their principle, Pristimerin, mostly in the bark of the root; it is possible to uncover the root, then scrape part of the bark and keep the plant for successive "milkings" in about yearly periods; this saves the trouble of having to plant new specimens, which can only be used after several years, when the new plants have reached a certain size.

In general we should aim at conserving our natural resources and making the best of the raw materials at our disposal. In this connection botanical laboratories can contribute notably to the economy of our country.

In his concluding remarks the Chairman reviewed the observations made by the various participants in the above symposium and stressed the need for further research in the field of antibiotics.

III. INDUCTION OF MUTANTS BY PHYSICAL AND CHEMICAL METHODS

Chairman : PROF. S. N. DAS-GUPTA (Lucknow).

1. DR. K. T. JACOB (Calcutta) : *Certain general aspects of irradiation work conducted at the Bose Institute.*

Irradiation experiments with crop plants using ionising radiations such as X-rays, was started by the author and his collaborators in the Bose Institute, in 1942. The plants under investigation at present are jute, cotton, paddy, sesamum, mustard and tomato and interesting results both from the fundamental and applied points of view, have been obtained in many of these.

On the basis of the generations in which the mutants are isolated, they can broadly be classified as "dominant", when they are selected in the X_1, N_1 or G_1 generations etc. and "recessive" if they are isolated in the subsequent generations. Both dominant and recessive mutants have been isolated by the author and his collaborators in this institute in jute, sesamum, mustard, paddy and tomato.

Dominant mutants, which are comparatively rare, have also been isolated in other plants as in tomato and peas, by Gelen, at the Weibullsholm Plant Breeding Institute, Sweden; in Red Clover and Poa, by Gosta Julen, at the Swedish Seed Association, Sweden; in Flax by Calvin Konzak, at the Brookhaven National Laboratory, U.S.A., etc. Instances of recessive mutants are numerous.

One dominant mutant isolated in jute in 1947, from an irradiated population of *Corchorus olitorius var R 26*, grew to a height of 22·5 ft. as against 19·42 ft. in the control. This had been carried on for nine generations and is breeding true. This gives an increased yield of about 50%, based on the dry weight of the fibres, which has been corroborated from anatomical studies also. This mutant, designated as "Tall Mutant" has purple stem and leaves when mature, as against the light brown to green colour of the control. Early flowering mutants also have been isolated, which flower in about 7 weeks, as against 17 weeks in the control.

In *Sesamum*, mutants giving a much larger number of fruits have been isolated, whose performances up to the X_6 generation have been tested. Some of these continued to give the higher yield, in the subsequent generations, while others gave a high yield in the next generation, then a low yield and then a high yield and so on. Still others in the subsequent generations gave a lower yield. There is yet another class of selections, which although gave a low yield in the X_1 generation, gave higher yields in the subsequent generations. A possible explanation for this behaviour is being given by one of my colleagues, Mr. U. K. Rai, in a subseqhent paper, when he deals with the results of X-radiation experiments in *Mustard*, in which also similar phenomena were observed.

Some of the selections flowered earlier than the control, the maximum earliness being 13 days as against the control, which took 48 days. But other irradiated progenies flowered later than the controls.

The oil content of the irradiated progenies were found to vary considerably. In some, they were lower than in the control, while in others they were much higher. The details were presented.

The oils extracted from the irradiated progenies were observed to be clearer than in the controls. On analysis it was found that the "red" pigmentation was absent, while the "yellow" was reduced to about half in many of these. But there were no significant differences in the refractive index, sap value, iodine value, percentages of non-saponifiable matter, saturated acids, oleic acids and linoleic acids. But the peroxide value of some of the samples extracted from irradiated progenies were lower than these in the controls, indicating better keeping qualities.

Two recessive mutants were isolated from *S. orientale* type 16, in the X_3 and X_4 generations. The former was white flowered, as against purple flowers in the control, while in the latter, the seeds were smaller than in the controls. The white flowered mutant had an oil percentage of 44·06, while the small seeded mutant had an oil content of 52·10% as against 41·42% in the control.

Paddy varieties, Bhasamanik and Patnai, obtained from the Central Rice Research Institute, Cuttack, were irradiated with beta radiations using S 35. In the former, a mutant with dark brown seeds was isolated from 25 uc treatment for 24 hours and in the latter, a red seeded and a small seeded mutants were isolated using 2·5 uc and 25 uc, for 6 hours, in the first generation. In addition to the change in colour of the husk, the leaf sheaths were also found to be coloured. The subsequent behaviour of these are being investigated.

The results of our irradiation experiments in mustard and tomato are being dealt with, by subsequent speakers.

2. DR. R. N. SINGH (Banaras) : *On an X-ray mutant of the hot spring Blue-green Alga, Mastigocladus laminosus Cohn.*

With a total dose of 500 r. units, it has been possible to obtain a physiological mutant of *Mastigocladus laminosus* Cohn.

The colour of the alga changed from light blue-green to intense dark blue-green. The colonies were almost spherical. The frequency of the reverse V-shaped loops and branches became greater and, on microscopic examination a number of 'giant' cells of abnormal size and shapes were frequently encountered. These in stained preparations showed clumping of the DNA threads at the centre due possibly to failure of division. The extracted nucleic acids showed a difference in the U.V. absorption peak over the controls. Besides, the irradiated alga acquired greater nitrogen fixing power and drought :resistance capacity.

3. DR. H. S. RAO (Dehra Dun) : *Genetic Improvement of Bamboos through Polyploid-Breeding.*

A preliminary observation in 1953 with 3 colchicine-treated seedlings of bamboo (*Dendrocalamus strictus*) suggested an extended trial the following year when 37 plants and 7 controls were prepared for field trial. In 1956 these two-year-old plants revealed interesting characters associated with polyploidizing, namely, increased vigour, production of thicker or wider leaves, and larger but fewer tuberculate hairs on the dorsal leaf-surface. The frequency tables compiled from data on vigour, leaf thickness and number of hairs show that in about a dozen out of the 37 polyploidized plants there is a definite increase in vigour, leaf-thickness and leaf width associated with increased size of hairs, the last effect resulting in fewer number of hairs per unit area. These easily observed criteria for early evaluation of artificial polyploid mutants are of great interest and value to breeders of forest species.

4. DR. R. Y. ROY (Banaras) : *Mutation by Chemical means.*

Double sectors in a pure culture of *Rhizoctonia solani* were observed by the author. Further studies of the sectors proved that both of them were similar. An isolation was made from one of the sectors and its morphological and pathogenic behaviour was studied under laboratory conditions. The author had previously reported (1951) that saltants could be obtained in *Rhizoctonia*, by the use of two organic fungicides having as their active principle Pentachloronitrobenzene (Fungicide popularly known as 'Folosan') and tetrachloronitrobenzene (known as 'Folosan D.B. 905'). Here then we find two types of saltants, viz., one occurring without the assistance of any outside agency, the other arising under the influence of chemical substances. The two types of saltants differ amongst themselves as well as they differ from the parent colony from which they originated, in following respects—(1) Radial growth; (2) Sclerotial formation, and (3) Colour of the medium after one month of their growth. There is no significant difference between the diameter of the hypha of the parent and that of two types of saltants. The most remarkable thing which has been observed by the author is that the first type of sector variant does not differ from the parent in its pathogenicity whereas the second type differs and is more virulent than parent when tested under laboratory conditions. Why and how of this can be answered only by further cytological work.

Besides *Rhizoctonia solani,* saltants have been reported by the author (1951) to appear in cultures of *Botrytis Cinerea* and *Alternaria sp.* when subjected to the influence of organic fungicides mentioned earlier.

5. **Shri M. S. Lal** and **Dr. S. N. Rao** (Sehore) : *Induction of Mutants by Physical and Chemical Methods.*

The various aspects of researches on physical and chemical mutagens have been reviewed by the authors.

A brief outline of the work on artificial induction of mutations in India has been presented. In this country, mutants of economic significance have been produced in wheat, cotton, sugarcane, jute and sesamum. Mutations have also been induced by X-ray treatment in rice, bajra (*Pennisetum typhoideum*), mustard, tobacco, chilli (*Capsicum annuum*) and ragi (*Elcusine coracana*). In the case of fruit trees, however, practically no work has so far been done in this country to produce useful mutants.

The value of mutations in the breeding of improved plants, in evolution of new species and varieties, and in genetics and medicine, has been discussed. The authors emphasize the need for further research on artificial induction of mutations and suggest the following lines of investigation :—

1. A method for making a clear distinction between intragenic and extragenic mutations should be evolved. For this, suitable techniques to observe minute changes occurring at sub-microscopic level should be devised.
2. Effects of temperature on mutation rate should be investigated.
3. Experiments with X-rays and other ionizing radiations should be carried out to confirm the findings that irradiation of nutrient medium indirectly affects the mutation frequency by producing some mutagenic chemicals.
4. The methods to determine quantitatively the contributions made by direct and indirect effects of radiation with respect to mutation, should be worked out.
5. The criticisms, levelled against ('Target Hypothesis" should be investigated by independent workers in different parts of the world.
6. Efforts should be made either to reduce the virulence of bacterial mutants which resist the effect of penicillin and other sulpha drugs, or to develop suitable mutants of blue mould (Penicillium) which may give penicillin of a different quality.
7. The relationship of somatic mutations with development of neo-plastic growths like tumours and cancers should be found out with conclusive evidence.
8. The natural mutation rate and genetic effects of radiation with respect to man should be worked out. This will help in developing suitable safe-guards against atomic radiation.
9. More mutations should be induced in both agricultural and horticultural crop plants. The results already obtained in India and abroad especially in Sweden, Canada, and U.S.A. justify such a contemplated research project to be initiated with confidence.

Further it is stated that in the years to come, Radiation Genetics, by developing new varieties of plants giving high yield, possessing good quality and disease resistance, etc. will become one of the most significant event in history of agriculture.

Finally the position of Radiation Genetics in India is discussed. The authors recommend that in order to give fillip to research on the lines suggested above, the Government of India should set up a National Institute of Genetics with its net-work of regional sub-stations in different parts of the country.

6. DRS. B. P. PAL, S. M. SIKKA AND M. S. SWAMINATHAN (New Delhi) : *Mutation Research at the Indian Agricultural Research Institute.*

In the mutation research programme in progress at the Division of Botany, Indian Agricultural Research Institute, New Delhi, physical agents like X-rays, Fast Neutrons, Ultra-violet rays and B particles from 32_p and 35_p, as well as chemical agents like Nitrogen Mustard and Mustard oil are being used. A wide range of crop plants and a large variety of treatments have been included in the study. The results obtained so far indicate that there is much diversity in crop plants as to their sensitivity to radiation. Some crops like wheat are easily affected while crops like paddy are less sensitive. Oilseed plants like mustard and linseed are extremely insensitive to radiation effects. Varietal differences in radiosensitivity have also been observed in wheat. Results from the use of different types of mutagens have shown that (*a*) chemical mutagens are of limited value since lethality is very much high in plants treated with them and that (*b*) neutrons will be useful for inducing mutations in polyploid plants since they seem to act selectively on the nucleus. From the practical plant-breeding point of view, the following effects have so far been observed : (1) in wheat material treated with 32_p, flowering commenced 4 weeks earlier than in the controls; (2) in some X-ray treated plants of the cotton variety 320 F, the mature anthers were closed and did not dehisce at all. In one plant, the staminal column was situated separately from the style thus facilitating easy emasculation. Such variations have not been reported in literature and the progenies of these plants will be of great interest for utilisation in the production of hybrid cotton seed. Thus, the outlook for induction of useful mutations in crop plants through the use of radiations appears hopeful.

7. DR. R. P. ROY (Patna) : *Mutagenic-like effects of Colchicine.*

The effect of colchicine as a polyploidising reagent is now well known. Most workers become satisfied with the doubling of chromosome number in the treated materials, but it is a common knowledge that by whatever methods, colchicine is applied, all the treated materials are not doubled. Those which remain undoubled after the treatments, are generally discarded or are not investigated further to study their genetical behaviour. Generally it is believed that those materials which remain undoubled, have not been affected. This is only partly true. The writer has treated several species and hybrids in the genera *Triticum* and *Aegilops, Mnisethea, Manusuris, Linum, Shorea etc.* In every case, many of the treated seeds or seedlings remained undoubled. These undoubled materials have been grown for two generations and they show a wide variation in several characters in comparison to the untreated materials of the same variety. Several of the treated plants differed from control in shape and texture of the leaves, in growth habits, in flowering period, in the number of seed per spike or fruit (specially in *Aegilops* and *Linum*) etc. These variations in the treated but "so-called unaffected" plants, have been found in second and third generations also in the case of *Mnisethia, Aegilops, Linum* etc.

It is proposed that these effects are due to changes at certain loci at the time of colchicine treatment. The action of colchicine is to inactive the spindle, consequently the chromosome do not separate at anaphase and remain in the same nucleus, resulting in the doubling of its number. The spindle is made up of fibres which are protein in nature (isolated and studied in the case of sea-Urchins eggs by Mazia and Dan, 1952). Thus it is evident that colchicine reacts with the protein molecules of the spindle fibre to inactivate it. This property of colchicine has not been thoroughly investigated, rather we know so little about it.

However, it should be remembered that in the chromosomes where genes are situated, considerable quantity of proteins are present, and hence it is quite likely that colchicine might be reacting to some extent with the proteinaceous part at certain places along the length of the chromosomes thereby bringing some changes at certain loci. This aspect of investigation of the properties of Colchicine is well worth investigation. Whether the variations reported to above, are genic or not, can be finally established only by breeding test which is in progress. But there is every indication that the change in the plant is almost of a permanent type.

8. SHRI M. G. SRIVASTAVA (Calcutta) : *'Induction of Mutations by Chemicals'.*

The question of the nomenclature of the effects of the chemicals on plants has been discussed. The three common names viz : 'Chemical mutagens' (Oehlkar, 1943), 'Mutachromosomics' (Battagalia, 1948) and 'Radiomimetic substances' (Loveless, 1951) have been described and it is suggested that the use of the wider rather than specific terms like 'Chemical mutagens' is more desirable.

Some of the cytologically active substances have been enumerated under their respective heads like elements, inorganic salts, organic salts and compounds etc. and the scope of their effects has been described. The nature of the effect of the chemicals on a cell has been classified as (1) Lethal or Toxic reactions, (2) Reversible physiological reactions and (3) Mutagenic reactions, which were discussed.

The study of the effects of some of the hormonal and non-hormonal herbicides in Bose Research Institute has been briefly summarized. The comparative effects of Amide of 2, 4-D, Ester of 2, 4-D, and 2, 4-5T on the meiosis of higher plants has been described for the first time. In each case, the inflorescences of *Crotalaria juncea* L. were treated with 500 p.p.m. of the chemicals for 24 hours and the buds were examined at meiosis. It was found that the abnormalities were of the order of 42·0% in Amide of 2, 4-D, 24·0% in 2, 4-5T and 13·5% of in B-ester of 2, 4-D as against 0·5% of the 'control'. The chief abnormalities were the lagging chromosomes, extrusions and few bridges both in I and II anaphase stages. The data was presented in form of a Table.

Besides, the effects of Amino-triazole (Na-Salt) in 100, 200, 1000 and 5000 p.p.m. (aqueous) concentrations on the root-tip mitosis of *Pisum sativum* (Sutton's Early Giant) have been described. It has been found that the chemical possesses high antimitotic property which was taken to explain the stunting of growth caused by such treatments. The abnormalities at the somatic metaphase and anaphase were found to be 5·0%, 12·0%, 17·0% and 18·0% respectively, as against 1·0% of the control and includes bridges, fragments, lagging chromosome etc. The mitosis was also found to be delayed due to the treatments. The data was presented in form of a Table. 'Chemical Target Theory' of Thoday has been discussed in the light of these observations.

In conclusion the action of cystein in reducing the effects of X-ray on *Allium cepa* (Frossbery and Nybom, 1953) has been mentioned and investigations on the protective action of other nitrogen compounds has been suggested.

9. SHRI UPENDRA KUMAR RAI (Calcutta) : *Genetical aspect of induced mutations by physical means.*

The increased yield of fruits and oils, earliness in flowering and the improvement in the quality of the oil as obtained by X-radiations in *Sesamum Orientale* types and *Brassica juncea* and *Brassica campestris* types, have been dealt extensively by Dr. K. T. Jacob.

The aim of the present paper, therefore, is to show how these potent source of ionizing radiations also helps in revealing the genetic complexities of these crops, which, otherwise, would have taken some years if at all, to appear spontaneously. It finds its truth in the saying that radiation experiments are short cut tools for the plant breeders.

For the sake of brevity, the results obtained to these effects have been dealt in three clear cut phases under the heads :—

(*i*) white flowered mutant of *Brassica juncea type Rai 5* isolated in X_2 generation, from 26,000 r treatment.

(*ii*) Nature and fluctuations in the yield of these crops at various dosages and

(*iii*) A multicoloured seeds mutant of *Sesamum Orientale type 12* isolated in X_4 generation from 56,000 r treatment.

(*i*) White flowered mutant obtained gives increased yield as against the control and its cousin and bred true in the subsequent generation. When crossed the flower colour segregates into the ratio of 15 yellow : 1 white. Though the number of plants were not sufficient to be analysed statistically, the segregation appears to be plausible on the basis of duplicate factor common in polyploids, the group to which *B. juncea,* having the amphidiploid origin, belongs.

(*ii*) On plotting the graph for fruit yield in various generations after the irradiation, it has been found that (*a*) Selections giving higher yield than the control continue to give increased yield in the subsequent generations, (*b*) Selections giving higher yield in the first two generations may at any one generation give less yield than the control and again in the subsequent generations continue to give higher yield as against the control, (*c*) Selection giving lower yield than the control in the first generation give higher yield in the subsequent generations and, (*d*) Selections giving lower yield than the control continue to give low yield in the subsequent generations.

The yield character is the quantitative character and is supposed to be governed by the multiple factors. From the above observation it is clear that the category 'a' and 'd' show homostatic nature where as 'b' and 'c' show heterostatic nature. It can not be definitely said whether these heterozygosity is at the allelic or genic level. The cytological observation show the presence of inversion bridges as the result of irradiation which are practically eliminated in subsequent generations, sooner or later. Therefore, this heterozygosity appears to be due to the inversion of a block of gene or a part of chromosomes producing heterozygosity in the alleles or genes respectively. Now if these inversions do not affect the localisation of chiasmata the heterozygosity produced have the tendency to stabilise in subsequent generations and thus result in the 'a' or 'd' type of behaviour. On the contrary, if these inversions affect the localisation of chiasmata at one period or the other 'b' and 'c' types of behaviour will result. This is being further analysed.

(*iii*) Multicoloured seeds mutant (Black, Brown, Gray Ash, White) have been isolated from *Sesamum orientale type 12* (Black seeds). The data is being analysed but it appears that (*a*) three pair of factors are involved in such behaviour, one of the pairs being lethal in dominant homozygous state and (*b*) two different parallel line of the development of colour based on simple Mendelian ratio takes place.

Thus these observations are direct evidences in establishing the usefulness of ionizing radiations not only from the economical aspect but also from the theoretical point of view, in understanding the genic constitution of plant and thus expediating in preparing the linkage maps therefrom.

In the end, the Chairman summarised the observations of the various participants and emphasised the need for an intensive study of the chemical and physical induction of mutations, both in their fundamental as well as applied aspects.

I. TEACHING OF ENTOMOLOGY IN THE UNIVERSITIES

Section of Zoology and Entomology

Chairman : DR. M. B. LAL, Lucknow.

As there were few speakers, this Symposium was held under the joint auspices of the Section of Zoology and Entomology and of the Section of Agricultural Sciences.

Dr. M. B. Lal, President, Section of Zoology & Entomology, presided and opened the topic. In his opening remarks he said that greater emphasis should be laid on teaching and research in *Fundamental* Entomology at the Universities, leaving out research in Applied Entomology to the various Research Institutions in the Country where better facilities for such type of work are available. The Universities have also to keep in view the time which can be devoted to the study of Entomology for this has got to be adjusted and co-ordinated with the teaching of several other branches of Zoology. It may be, therefore, necessary to review and suitably modify the entire syllabus for teaching Zoology at the Universities.

1. DR. P. J. DEORAS (Bombay) :

At the present there is great demand for entomological workers in the Agriculture and medical department, Insecticidal concerns and for pure research in the Universities. The training is imparted at some Universities and at the various Agri. Colleges and Institutions. The students that come for training in the Agr. College for Entomology do not have the graduate standard training in Zoology because of other work, as such something of the academic background is lacking in them. Students that take entomology in the University do not get the field training which is readily available in an Agr. Institution.

To get a properly trained entomological worker then one has to have an academic background to be followed by a proper field training in Ecology, Biology, systematics and also control measures.

In view of the great need of entomological workers it would therefore be desirable to formulate a coordinated scheme which would see that the training is adeqvately imparted. This could be done by pooling the resources of the available institutions. The Zoological Society of India and the Entomological Society would be ideal for such coordination. A pure science Biology graduate who possesses B.Sc. with Zoology as the main subject should be the raw material for training. He is first given an intimate knowledge of morphology, physiology and preliminary systematics in a University science college. He should be attached for some period, say six months, to an Agricultural College or Institution. Here he gets to know the pests, collects and pins insects, studies their biology and tries control measures. This will take one year. He is the material who should now go to any Agricultural, Medical, Zoological, or University postgraduate department for a degree by research in Entomology. Such degree holders would be the proper persons to work up Entomological Schemes.

Considering the paucity of trained personnel in this field, should not the workers sit together to have such an integrated programme for National development? The Universities should take the lead.

2. S. MASHHOOD ALAM (Aligarh) :

After graduation the post-graduate teaching should be of full two years on the lines of the Aligarh Muslim University. The first year is to be devoted on the study of Advanced Zoology. In the second year Entomology should be taught by dividing it into three independent Theory papers : first paper consisting of Morphology, physiology, development and metamorphosis; second paper dealing with classification, biology of insects of agricultural importance, palaentology and zoological nomenclature; third paper containing ecology, biology of insects of medical and veterinary importance and the methods of control. Extensive laboratory work on all the three papers and the field study should form the syllabus for practicals. A team of specialists on important branches of Entomology be entrusted with the job of teaching. This will lead to a balanced teaching of the subject and the students will be kept in touch with modern researches as well.

Post-masters degree (Ph.D.) should be awarded on original research work carried out for at least two years under the supervision of some specialist. The research problem should cover maximum field of any particular aspect of Entomology so that student on its successful completion develops genuine self-confidence. Any tendency to produce more students irrespective of capacity to do so will be suicidal both for students and the nation. Regular research monograph should be written on Indian insects on the lines of 'On Indian Insect Types' which are being published by the Aligarh Muslim University. Such publications are indispensable for students engaged in post-graduate specialization, as well as, for those carrying out research in Entomology.

3. DR. S. PRADHAN (Pusa, New Delhi) :

This subject has been discussed in several sessions of the Indian Science Congress (1938, 1950, 1951) and the need for proper teaching of Entomology in the Universities has been stressed again and again. Also these repeated discussions have not been without some effect. The need is now almost unanimously recognised so much so that in response to any advertisement for an entomological post there are always a large number of applicants who claim to have passed the M.Sc. examinations of various universities with Entomology as a special subject. But when these candidates, often with good divisions, appear for the interview they often do not fare well. The blame for this state of affairs is neither with the teachers nor with the taught. The exact nature of the problem has not been appreciated properly, and the proper role of the universities in the teaching of Entomology has not been demarcated.

Although, according to the phylogenetic classification the whole of the insect world is included in just one of the five major classes of the phylum arthropoda which in its turn is just one of the fifteen major phyla of the animal kingdom, the number of species of insects is more than two thirds of the whole number of animal species known. Thus whereas from the point of view of pure academic teaching of Zoology the class insects may appear to claim not more than one seventyfifth of the total attention the requirements of teaching from the applied point of view are that sixtysix per cent of the total attention be devoted to insects.

In response to the market value of entomological knowledge several universities have introduced Entomology in their curriculum but inclusion of additional topics in the syllabus, unless it is accompanied by a judicious exclusion of a proportionate number of existing topics can only result in mental indigestion. This is what appears to be taking place. With the development of science in general and with the increasing appreciation of the economic value of various specialised branches the university syllabus is continuously increasing while the time and energy available for the study of that syllabus remain constant if not actually decreasing due to increasing diversions of various kinds. It is time to reorientate our whole teaching programme.

The teaching of biology now starts in the school itself and it is time to introduce Botany and Zoology as separate subjects at the Intermediate stage, maintain these two as distinct subjects only upto B.Sc. and then at the M.Sc. stage divide Zoology into separate branches of which Entomology should be one. Now the subject of Zoology is so vast that M.Sc. in Zoology has become a misnomer. The syllabus of the successive classes can easily be pushed backwards by two years in order to accommodate modern knowledge in front.

As regards the relation between the universities and the research institutes I do not visualize the necessity of any clash at any time. The pride of the universities has always rested on the cultural and academic standards while the institutes are meant to serve the specific needs of the industry. The universities are better suited for problems requiring individual concentration of the highest order whereas the research institutes can better afford to concentrate on long range problems requiring team work.

Shri D. D. Mukerji also participated in the discussion.

Dr. E. S. Narayanan, President of the Section of Agricultural Science kindly agreed to wind up the discussion and elaborated upon the points raised by the various speakers.

II. CELLULAR REACTIONS TO STIMULI

Chairman : Dr. M. B. Lal, Lucknow.

Dr. M. B. Lal, President of the Section of Zoology and Entomology, introduced the subject and mentioned that a much greater understanding of the physiology of the behaviour of animals during growth and other life-activities is now possible due to the interesting results of the researches in the field of Cellular reactions.

1. Dr. SIVATOSH MOOKERJEE (Calcutta) : *Nature of inter-cellular stimuli in hydra.*

It appears that we have more facts about extra-cellular stimulations at our disposal than those which deal with the inter-cellular stimuli.

Cell-reversals in hydra are particularly important in elucidating facts related to the question of origin of inter-cellular stimuli. Suitable grafts—anterior and posterior—at different levels, fusion and regeneration experiments indicate the existence and operation of inter-cellular stimuli. The efficacy of such stimuli has not been fully understood, however, it presents some inclings to (i) incidence of mitosis; (ii) increase in cell number; (iii) mosaic nature of interstitial cells and (iv) regularity of organization pattern.

2. Dr. B. N. SINGH, Miss S. MATHEW and M. SREENIVASAYA (Lucknow) : *Reactions to stimuli.*

As bacteria and amoebae live in close association in human and animal intestines, a detailed study of the amoeba excystment factor or factors produced by the common intestinal bacteria may lead to a more effective cure of chronic amoebiasis.

Excystment in protozoa has been attributed to various factors such as the replacement of media by fresh solution, hypo- and hyper-tonicity of the medium, change of pH, low oxygen tension, reducing agents, change of temperature, presence of organic infusions and bacteria etc. Earlier workers have not adequately recognized the risk of extraneous infection inherent to such experiments, particularly when rich nutrient media are examined for the presence of the excystment factor. Unless completely asceptic conditions are maintained, the results will remain open to doubt.

In the work presented in this paper, it has been shown that an excystment factor is produced by the actively proliferating cultures of *Aerobacter aerogenes* and *Escherichia coli*, which is capable of diffusing easily and rapidly through a collodion membrane. The factor is thermolabile and does not appear to be related to either pH or to any of the reducing substances tried by us, although both these factors may be expected either to condition the cysts to the action of the excystment factor or augment its potency. Work on the isolation and further characterisation of the factor is in progress.

3. DR. B. M. GUPTA (Lucknow) : *Antibiotic sensitivity and biochemical reactions of virus resistance and susceptible strains of Escherichia coli.*

Phage is a powerful stimulus for bacterial cell. Even though only a small part of the virus enters the cell it is sufficient to divert the entire metabolic machinery of the cell towards synthesis of newer brood of virus particles. As to how this is achieved, while the legitimate activity of the bacterial nucleus is subordinated, we still have no precise answer. Not all cells in a population of bacteria exposed to phage will react this way; there are survivors which are immune to virus attack. The nature of resistance in every case is not fully understood.

While working with a virus (designated as CUX-5) of *Escherichia coli*, it was found that the surviving cells refused to adsorb the virus particles. These resistant cells like the susceptible ones are able to ferment dextrose, lactose, mannitol, glycerol, xylose, arabinose, dulcitol and adonitol, and are unable to metabolise inositol, dulcitol and adonitol or even utilise sodium citrate. Both are devoid of any gelatinase or urease activity and give positive methyl red reaction and produce indol from tryptophan. The enzyme nitrate-reductase is possessed by both, and neither of them produce acetyl-methyl carbinol. They are equally sensitive to aureomycin and streptomycin.

Above results confirm the view generally held that the common intracellular enzymes are very little altered, at least qualitatively in bacteria resisting virus entry. Clue to resistance must reside on the cell surface. If we assume that streptomycin or aureomycin attaches itself to specific receptors of the cell surface as first step to inhibition, the inescapable conclusion is that these receptors are different from those concerned with virus adsorption. In *E. coli* resistant to virus either the virus sensitive receptors are absent or that they are marked by specific inhibitors. Information of this nature may be of help in the chemical characterisation of virus receptors of cell surface of susceptible bacteria and in the isolation of compounds that are concerned with resistance of bacteria to virus.

4. DR. B. S. SAUSHIVA (Lucknow) : *Effect of chemotherapeutic agents on amoebae.*

During screening of amoebicidal compounds observations on the susceptibility and viability of *Entamoeba histolytica, Hartmannella rhysodes, Hartmannella glebae, Naegleria gruberi, Schizopyrenus russelli, Didascalus thorntoni,* and *Acanthamoeba sp.* have been made. The susceptibilities of amoebae to chemotherapeutic agents vary considerably and there is difficulty in interpreting these differences. Conessine has been found to be more active on free-living amoebae than emetine. Among the arsenic derivatives of thiazolidones and thiazoles, the various amoebae show correlated activity against the latter compounds but no correlation is found against the former ones. It may be, perhaps, that thiazole ring is the active pharmacophore in these amoebae. The amoebae on exposure to anti-amoebic compounds show physiologic injury resulting in their death. In the actual occurrence of death a number of factors must be involved and the resultant death in each case is not necessarily caused in the same manner. In rapid death amoeba meets a violent end shortly after exposure to a concentrated solution of a drug. It bursts spontaneously like a soap-bubble as the damage to the cellular material is extensive. In cases of delayed death, the distended still pictures of amoebae with heavy granulation and/or vacuolation appear to be the common condition preliminary to loss of viability. The criterion of survival is the ability of amoebae to move, to multiply and to produce a culture.

Shrimati Mridula Datta also participated in the discussion.

Dr. B. R. Seshachar kindly agreed to wind up the discussion and elaborated upon several points.

I. PLEISTOCENE PLUVIAL CYCLE IN PENINSULAR INDIA AND ITS PROBABLE CORRELATION WITH GLACIAL CYCLE IN EXTRA-PENINSULAR INDIA

Section of Anthropology and Archaeology

1. NIRMAL KUMAR BOSE (Calcutta): *Correlation of the Glacial and the inter-glacial periods with the wet and dry phases of climate.*

The problem of dating palaeolithic tools in peninsular India is intimately connected with the dating of certain fresh-water deposits which bear tools and the matrix of which, in some cases, has been lateritized.

The sequence established in several sites in Mayurbhanj has been as follows: A boulder bed lying about 3 ft. above a calcareous bed of clay has been found to contain pebble tools of crude workmanship. This is followed above by about 6 ft. of pebble bed with unconsolidated matrix, which has yielded crude bifaces, followed by bifaces of superior workmanship, in Churgunia ghat, and possibly also in Mukurmatia. The Kuliana beds, four miles away, have yielded crude and finished bifaces and choppers, but no pebble tools of the kind associated with the lowest bed in Churgunia.

So far, no fossils have been found with the tools. Heavy mineral analysis has also failed so far to draw any line between the subdivisions of the upper beds which have yielded tools. On typological grounds, Sen (1954) has suggested that the Kuliana deposits may be considered to be of middle pleistocene age.

In any case, search has continued in the bed carrying pebble tools for its actual lower limit. At one site on the Burhabalang, the underlying sticky clay has yielded tree-fossils (Bose 1952). Chaudhuri and Sarma have recently discovered bovine teeth from this zone; and they are of opinion that this may be indicative of pleistocene date. We do not, however, know the extent of the gap between this bed and the tool-bearing bed above. Investigation is still being carried on for establishing the exact relationship between the two.

In trying to establish a climatic correlation between the tool-bearing beds of Mayurbhanj and Soan in the Punjab, Krishnaswami (1947) has used the sequence of terraces in the Attirampakkam nullah near Madras, as evidence of the succession of a wet and dry phase of climate. Sen has suggested that laterites and non-lateritized beds may indicate a succession of wet and dry phases (1954).

As far as we know at present, laterite is formed under certain lithological conditions, provided there is a heavy precipitation followed by a dry season, during which water seeps into the soil, leaches out certain minerals and is then drawn up above to replace certain other minerals. Laterite needs for its formation, a particular succession of wet and dry months. Today, it can be observed under formation in places having a mean rainfall of 20 in. as well as at 50 in. and above. When the mean annual rainfall is too low, or too high (when the land is too dry or really not dry in any part of the year), laterite is not likely to be formed. So, the mere process of lateritization or its absence in a certain place may or may not be indicative of a succession of wet and dry phases of climate. It indicates change of condition; but whether from wet to dry, or from more contrasty to an evenly spread out rainfall, we do not know. This is why it is suggested that the correlation is yet premature.

Secondly, Chaudhuri and Sarma have tried to show that the Baripada beds show evidence of the advance and regression of the sea and of local uplifts and depressions within a range of about 50 ft. If this is correct, then this may also explain why the river at Baripada, and ten miles beyond, was able to carry pebbles and boulders at one time, and clay at another. The observed succession may be easily related to minor coastal oscillation instead of to widespread climatic changes which affected the volume of the river's flow.

The attempt to correlate the alternating lithological character of the tool-bearing beds in Mayurbhanj with tool-bearing beds or terraces in extra-peninsular India is therefore yet premature. The river-terraces reconstructed by Krishnaswamy (1947), although very suggestive, have one unconvincing character about them, namely, they are based on several distinct river valleys, and a composite reconstruction was made out of them. More detailed local investigation along similar lines is needed before the terrace sequence in Madras can become generally acceptable.

That is one direction in which work has to proceed. On the other hand, the exact junction of the lower tool-bearing bed and the underlying one carrying bovine teeth has to be looked for, for purposes of more exact dating by fossils. Fresh-water micro-fossils have also to be searched for in the tool-bearing beds in the hope that they might yield better evidence of the wetness or dryness of contemporary climate. When these become available, the task of correlation of extra-peninsular tool-bearing beds or terraces with similar beds in peninsular India would become possible. Perhaps this would also help us to correlate the tools of East and South Africa with those of India on sure geological evidence. The tools themselves should not be used, in the present state of our knowledge, as index fossils.

2. D. SEN (Calcutta) : *Correlation of Pluvial and Glacial cycles in India.*

The Pleistocene has been defined as an epoch of great climatic change. The results of the climatic change are basic in determining the subdivisions of this epoch. But different techniques must be employed in different regions where the problem of pleistocene stratigraphy varies (such as in the glacial, periglacial and unglaciated regions) to place each stratigraphic unit in its proper order. In glaciated regions e.g. in the Himalayan regions of N. India, a succession of deposits of glacial and interglacial origin has been recognised and directly correlated with the climatic cycle. In the periglacial region such as the piedmont and adjacent plains of the Punjab, close correspondence exists between glaciation, gravel accumulation and pluvial conditions. Pluvio-glacial outwash stream terraces and deposits, loess etc. can be tied to ice advances and recessions by actual traction.

But difficulties in correlation increase with distance from the glaciated regions such as in tropical peninsular India where there are no direct means of correlation. The problem of pleistocene stratigraphy in such regions is manifold and difficult, though their ultimate solution may be based on the recognition of the results of climatic fluctuations which however are less pronounced in these regions. These climatic fluctuations appear to have produced either intensified or lessened precipitation along with temperature changes. Gravels, fossil soils, flora, fauna etc. may indicate past climatic conditions that often differ only slightly from those of the present. The relative sensitivity of fauna, flora, soil erosion etc. to these changes of climate must be ascertained. Without widespread horizon markers, correlation is difficult or would be highly speculative.

In some regions of Peninsular India e.g. in the Sabarmati and Mahi valleys in Gujarat and the Malprava basin in Karnatak, oscillations of climate between wetter and drier conditions have been observed though not on the same scale and it has not been possible to correlate the same with the glacial cycle in the north. In Madras, a terrace sequence has been reconstructed but its correlation with the Punjab terrace sequence is highly speculative. Tool-types should not be used as stratigraphic horizon markers for correlation purpose. A pluvial cycle for the region must be recognised before correlation is attempted. In this connection, the occurrence of implementiferous redeposited laterite in peninsular India calls for special study to find out the climatic and other factors involved in their formation and whether it may be used as a climatic indicator, if it is dated within pleistocene. According to deTerra (1943), fossil laterites suggest former humid tropical or subtropical climate, and lateritic (ferruginous crust) or ironstone hardpan suggests comparatively dry climate.

In Mayurbhanj, the problem of pleistocene stratigraphy is being tackled by different techniques. The river deposits in the cliff sections on the Burhabalang suggest climatic fluctuations between comparatively humid and dry conditions. This has to be established by further studies along the river. The upper and the lower limits of the series are to be defined. Soil samples are being examined for micro-fossils. The presence of a fossil bovid in the clay (bottom layer of the series) below the lateritic gravels suggests an early pleistocene age and thus the identity of the pleistocene stratigraphic units may be established. Further finds are awaited. Local or regional climatic cycle must first be recognised and tools securely dated, before correlation with the north is attempted. We have not reached that stage for correlation as yet.

3. A. CHAUDHURI (Calcutta) : *Pleistocene Pluvial cycle and its correlation. Epoch nomenclature*

Lyell (1833) named certain sedimentary beds in Sicily (Italy) as belonging to the newer Pliocene or early Pleistocene in which the number of species of fossil mollusca were identical with modern forms so much so that they constituted about 90 to 95% of the whole. These Sicilian beds, with their content of mollusca, therefore, formed the basis of the nomenclature of the epoch by Lyell.

This percentage basis of mollusca of Lyell does not hold true any longer in respect of nomenclature of epochs of the Tertiary and Quarternary but the fact remains that the epochs of the Tertiary and Quarternary named by him are distinct both faunally and stratigraphically.

Criteria for nomenclature

Criteria for the nomenclature and classification of the Pleistocene are :

(*i*) Beginning of Quarternary glaciation;

(*ii*) appearance of a number of mammals especially of Boselaphus, Bos, Bubalus Camelus; Presbytis, Pongo; Canis, Melursus, Panthera, and the disappearance of a number of other forms;

(*iii*) appearance and disappearance of new and old floral components;

(*iv*) acme of development of some marine invertebrates, viz., foraminifers, bryozoans, alcyonarian corals;

(*v*) (*a*) fluctuations in climatic conditions—dessication due to abstraction of water by glaciers or momentous physiographic changes due to rise and fall of land-surface resulting from late Pliocene upheaval of the Himalayas;

(*b*) fluctuations of sea-level bordering on the continental platform, especially in the shelf areas below the "ghats" of India;

(*c*) lateritisation in lower levels, more particularly in coastal areas, and the occurrence of lithic implements in the laterite.

Scaling the Pleistocene

From the above, it is obvious that the Pleistocene epoch can be separated from the Pliocene and then scaled off into compact units.

In our country, the Pleistocene is separated from the Pliocene by a pronounced unconformity, so much so that the topmost portion of Pliocene is absent through erosion. This is true of the Himalayan area.

In the continental area, our knowledge gravitates around a few freshwater deposits of Narbada and other rivers which, on faunal evidence, are of middle Pleistocene age, and which coincide with the so-called 'older alluvium'. Characterisation of the older alluvium in respect of its lithology, fossil flora and fauna, structural peculiarities, environment of deposition is so inadequately known that it does not provide any substantial basis for further work in specialized lines; the beginning of a full-scale study of the older alluvium and its equivalents is yet to begin.

Geological studies of the Pleistocene deposits of the coastal areas have not yet been undertaken in any details.

Vredenburg (1904) made a study of some fossil oysters from a marine band in Calcutta.

P. N. Bose (1904) described an oyster-bank at Mahulia, Baripada, Mayurbhanj. This bed is known as the Baripada bed and its geological age is thought to be Lower Miocene.

Again, in 1903, he gave notice of a boring at Baripada which reached a depth of 163 ft. At 142 ft. from the surface a limestone band, crowded with smaller foraminifer genera Amphistegina and Rotalia, was found.

A number of geologists, Eames (1936), Jena (1942 and 1943), Chatterjee (1945), Modak (1952) have gone over the Baripada bed since then and affirmed that it was of Lower Miocene age.

N. K. Bose (June, 1955) with a party visited the Baripada beds. Sections were measured from Norbania on the north to Pratappur to the south and samples taken from the measured sections. At Mukurmatia, immediately below the laterite band, a bovid tooth was obtained.

Kiran Chandra Sarma (1955-56) followed up the work in fulfilment of his M.Sc. thesis in geology of the Calcutta University for 1956. The results obtained from his study of the sections of Baripada beds show that these beds are of much younger age than miocene, so much younger that it may be placed even in the lower Pleistocene.

Sarma's sections and fossils will be available for examination during the session of the Congress.

II. FIELD METHODS IN CULTURAL OR SOCIAL ANTHROPOLOGY

1. M. N. BASU (Calcutta) : *Field Methods in Cultural or Social Anthropology.*

Investigation in the field of cultural or social anthropology is a means to an end and not an end in itself. The investigations are usually undertaken for various purposes such as—administrative, legislative, political, economic, commercial, industrial and scientific. The purpose influences the nature and scope of the investigations.

In every aspect of human life practical knowledge is more valuable than theoretical. To study the methodology of field-work, practical work in the field is more effective than any theoretical one. Before going to the field it is essential that one should equip himself both intellectually and materially.

There are three different methods of investigations in the field by a cultural or social anthropologist, viz.—

(1) Narrative method, (2) Direct observation method, (3) Genealogical or case history method.

An interviewing technique known as Indirect Approach to the people should be taken into consideration. Selection of informants is also an important task for the collection of data in the field.

A great obstacle is usually encountered during field investigation in respect of language. A field worker, when going to the field should be linguistically equipped to render in accurate phonetic transcription of the names of the people, places etc. The other alternative is to engage an interpreter. Engaging of more than one interpreter is essential as this ensures a more adequate check on the information obtained.

In the field-work of Cultural or Social Anthropology the conception and the approach derive from the fact that problem is essentially human in nature. Cultural or Social anthropology is not a laboratory science—its laboratory is the field. Field is the testing place of its theoretical knowledge. The real field-work is a scientific discipline and routine. This makes vigorous demand on the patience and perseverance of the worker. So honesty, sensitiveness and an abundant sense of humour are essential for a field worker in the field of cultural or social anthropology. If he is equipped with these he will find the horizon of the field clear inspite of unavoidable difficulties and frustrations in the path.

I. CORONARY ARTERIAL DISEASES

Section of Medical and Veterinary Sciences

Chairman: Dr. C. R. Das Gupta.

1. K. S. MATHUR (Agra) : *Pathology of coronary artery disease.*

Many diseases may affect the coronary arteries and even encroach on their lumen—syphilitic aortitis with narrowing of the coronary ostia; rheumatic arteritis; inflammatory changes associated with a variety of infectious diseases like diphtheria, scarlet fever, typhoid, influenza, pneumonia; periarteritis nodosa; thrombangitis obliterans; emboli most commonly associated with bacterial endocarditis; trauma, rupture and aneurysm of coronary artery; scleroderma; amyloid disease; congenital abnormalities and others. These conditions are responsible for less than 10 per cent of all coronary artery diseases. Atheromatosis leading to narrowing and even complete obstruction is the commonest leison responsible for more than 90 per cent of coronary arterial diseases.

Since practically the totality of coronary arterial disease is atherosclerotic in type, Coronary atherosclerosis is implied whenever the term "Coronary artery disease" is used without other qualification. Coronary artery disease is not synonym with heart disease, for even advanced coronary atherosclerosis is consistent with absence of significant pathologic or clinical evidence or electrocardiographic evidence of myocardial damage. White has advocated the use of the term "Coronary heart disease" for the various effects of coronary arterial diseases on the heart deleterious enough to cause symptoms and signs or postmortem evidence of more than trivial damage to the heart itself—thus myocardial ischemia with angina pectoris or electrocardiographic abnormalities due to coronary disease, acute myocardial infarction and old scars of similar origin are all included under this heading.

MATERIAL AND METHOD

This paper is based on the study of 1284 consecutive autopsies at Schlesingers laboratory during the decade 1941-50, in which the hearts were studied by injection plus dissection of the heart in every case that went to autopsy. The right, the left anterior descending and left circumflex coronary arteries were injected simultaneously with different coloured radio opaque masses under pressure of 150 mm. Hg. The heart was then unrolled so that all of the coronary arteries lay in one plane and a roentgenogram was made. A complete dissection of the arteries was then carried out with roentgenogram as a guide.

Slight to moderate atheromatous lesions, represented by superficial yellowish lipoid flecks, streaks or nodules on the intimal surface and thick lipoid fibrous or calcified intimal plaques protruding into and encroaching part of the lumen commonly found in hearts from people over 40 years age, were not included in this study. Only those cases have been selected for detailed study, in which the pathological examination of the heart revealed extreme degree of atherosclerosis with an occlusion of a major coronary artery or of a branch, with or without gross and histological evidence of myocardial infarction.

INCIDENCE OF CORONARY ARTERY OCCLUSION

Coronary artery occlusions were met with in 342 hearts or 26·6 per cent of 1284 autopsied cases.

TABLE I

INCIDENCE OF CORONARY ARTERY OCCLUSION

Total number of Hearts	1284
Hearts without occlusion	928
Hearts with occlusion	342
Percentage of Hearts with occlusion	26·6

The incidence of coronary occlusion used to be low in early series when they were studied by dissection alone. Gordon *et al* (1939) had reported 203 hearts or 11 per cent of a total of 2898 hearts studied as having coronary artery occlusions and Ackerson *et al* (1939) found 30 or 7·5 per cent occlusions amongst 398 hearts. Schlesinger (1941) reviewed his early series of 69 hearts or 10·5 per cent of a total of 660 hearts with occlusion when dissection alone was employed and compared it to 94 or 23·5 per cent hearts with occlusion out of a total of 400 hearts from autopsies on persons over 20 years of age, after the injection plus dissection technique was introduced by him for the study of coronary arteries. Significantly large number of occlusions have therefore been disclosed since the introduction of injection plus dissection technique.

AGE AND SEX DISTRIBUTION OF CORONARY OCCLUSIONS

There was no case of coronary artery occlusion in hearts of persons under the age of 20 years, only one in the age group 21—30 years, 31 and 40 years, while the maximum incidence was between 51 and 80 years.

The male hearts predominated in the incidence of occlusions compared to female hearts but the difference was less and less marked beyond the age of 50 years.

TABLE II

AGE AND SEX DISTRIBUTION OF CORONARY OCCLUSIONS

Age	Sex	Number
21—30	M	1
	F	0
31—40	M	4
	F	1
41—50	M	13
	F	8
51—60	M	58
	F	32
61—70	M	82
	F	46
71—80	M	44
	F	33
81—90	M	6
	F	4
Total		342

Attention had been drawn to high incidence of occlusions by Schlesinger (1940) when he recorded 40 per cent of hearts with coronary artery occlusions in males over 55 years in his study of 225 injected hearts. The infrequency of such leisons in the young females is a common observation.

NUMBER OF OCCLUSIONS IN EACH HEART

Out of the present series of 356 cases, only 176 hearts were studied in detail with regard to number of occlusions of the coronary arteries and their branches. 82 hearts or 46·6 per cent had only one occlusion and the remaining had two or more occlusions. Fresh and old occlusions are usually present in the same heart. Fresh thrombi are red, soft and friable. Old thrombi are firm, grey and securely attached to the wall of the artery.

TABLE III

NUMBER OF CORONARY OCCLUSIONS IN EACH HEART

Hearts with 1 occlusion	82	46·6 per cent
„ „ 2 „	48	27·3 „
„ „ 3 „	28	15·9 „
„ „ 4 „	11	6·2 „
„ „ 5 „	6	3·4 „
„ „ 6 „	1	0·6 „
Total	176	100 per cent

Gross and Friedberg had observed multiple fresh and old coronary occlusions in about 85 per cent and a single coronary occlusion in only 15 per cent of 120 hearts with coronary occlusions. Blumgart *et al* in a study of hearts lay a combined dissection and injection method also found that more than one occlusion was usually present in the hearts showing advanced coronary sclerosis, thrombosis or myocardial infarction.

Multiple coronary thrombi are thus found more often than a single thrombus. Many thrombi are overlooked because of failure to examine carefully all of the branches of coronary arteries throughout the entire extent; occasionally thrombus is expelled by dissecting scissors.

LOCALIZATION OF CORONARY OCCLUSION

The site of occlusions in the main stems and branches of coronary arteries were studied in 176 hearts. They showed 360 occlusions, which were distributed as follows :—

TABLE IV

SITE OF CORONARY OCCLUSION

Coronary Artery	Number of Occlusions	Percentage
Left Descending	150	41·6
Left Circumflex	85	23·6
Right Coronary	125	34·8
Total All Three	360	100·0

In the present series, occlusions occurred most commonly in the anterior descending branch of left coronary artery, less commonly in right coronary artery and least of all in the left circumflex coronary artery. These observations are in conformity with Wood (1951) who on the basis of results of Barnes and Ball (1932). Appelbaum and Nicholson (1935) and Munck (1946) concluded that anterior descending branch of left coronary artery is thrombosed in 66-75 per cent, right coronary artery in 25-40 per cent and left circumflex in 5-33 per cent cases. In a twenty years experience at Massachusetts General Hospital, White (1951) found the left coronary artery to be thrombosed much more commonly than the right coronary artery. Horn and Finkelstein (1940) had examined 100 autofared cases of acute coronary occlusion and observed 61 occlusions of right coronary artery, 56 in left anterior descending, 27 in left circumflex, 15 in the ramus primus and 7 in the branch to the obtuse margin.

Our observations do not lend any weight to the former belief that occlusions occurred predominantly in anterior descending branch of left coronary artery. Lavine and Brown (1929) had noted occlusions of left anterior descending branch 39 times in their 46 cases of fatal coronary thrombosis.

RELATION OF CORONARY OCCLUSION TO CARDIAC INFARCTION

Occlusion of a coronary artery is not invariably followed by myocardial infarction nor is very infarct preceded by coronary thrombosis.

TABLE V

RELATION OF CORONARY OCCLUSION TO INFARCTION

Total number of hearts	1284
Hearts with occlusions	342
with infarction	254
without infarction	88
Hearts without occlusions	942
with infarction	14
without infarction	928

Out of 342 hearts with occlusions of coronary arteries 88 or 25·6 per cent did not show any infarct on gross or histological examination. Benson (1940) had observed 50 cases of recent coronary thrombosis without infarction among 1750 autopsies in Portland morgue. Wood (1951) estimated that coronary thrombosis occurs without infarction in 20 per cent cases. The occlusions of one major coronary artery may not be followed by cardiac infarction either because death ensues too rapidly i.e. within a few minutes or a few hours or because flow of blood through collateral channels maintains viability of the affected myocardium.

Myocardial infarction was present in 14 hearts without evidence of coronary occulsions. One of them was a male, aged 42 years, who died of anteroseptal myocardial infarction, had ten points of extreme narrowing but no occlusion of the coronary arteries. Another male, aged 53 years, developed shock following subtotal gastrectomy for duodenal ulcer and died of acute anterior myocardial infarction without coronary occlusion. A 73 years old female had a fracture hip with diabetes. She developed post-operative shock on fourth day when needling was done and died of anterior infarction.

LOCALIZATION OF MYOCARDIAL INFRACTION

Gross as well as histological examination of the myocardium was done to ascertain the position of infarcts. The following table gives their location.

TABLE VI

LOCATION OF MYOCARDIAL INFARCT

Total number of hearts examined	1284
Hearts with myocardial infarcts	268
Anterior wall	118
Posterior wall	71
Anterior and posterior wall	69
Septum	6
Right ventricle	2
Right auricle	2

Posterior Infarcts :—

There were 140 hearts showing posterior wall infarction including 69 cases of both anterior and posterior wall infarction accounting of 52·2 percent of 268 cases. The precise location of these infarcts in the posterior wall was charted in the unrolled heart by mapping out upper (based or high posterior), middle (diaphragmatic) and lower (apical) zones.

TABLE VII

LOCALIZATION OF POSTERIOR WALL INFARCTS

Upper Zone	Middle Zone	Lower Zone	Upper 2 Zones	Lower 2 Zones	Upper & Lower Zones	All 3 Zones
15	11	10	28	22	2	52

Infarction was limited to a single zone in only 36 hearts or 25·7 per cent of the series and all three zones were involved in 52 or 37·1 percent. Upper two zones combined were infarcted as frequently as the lower two zones. There were only 2 purely lateral infarcts and none of them confined to high laterobasal position.

Out of these 140 infarcts 15 were classified as small infarcts, 43 medium sized and the remaining 82 extensive infarcts. 105 were recent and 35 old posterior infarcts.

Anterior Infarcts :—

187 hearts showed anterior wall infarction including 69 cases which had both anterior and posterior infarction accounting for 69·7 percent.

TABLE VIII

LOCALIZATION OF ANTERIOR WALL INFARCTION

Upper Zone	Middle Zone	Lower Zone	Upper 2 Zones	Lower 2 Zones	Upper & Lower Zone	All 3 Zones
4	9	66	6	55	3	44

Majority of the anterior infarcts are located in the lower two third of the anterior wall accounting for 121 hearts or 64·7 percent. All three zones were involved in 44 cases or 23·5 percent. There were 19 cases or 10 percent infarcts compared to upper two third.

Septal Infarcts :—

The infarcts were confined to septum in 6 cases although the infarcts had extended from adjacent areas to the septum in 108 cases. These included 31 hearts in which anterior and posterior walls and septum were all involved.

Right Ventricle and Right Auricle Infarcts :—

Practically all the infarcts are confined to left ventricle. Only 2 cases in the present studies showed isolated infarction of the right ventricle, although 34 other infarcts had extended to the right ventricle from the left. Right auricle was infarcted in 2 cases.

From an analysis of 160 cases of infarction among 2000 consecutive autopsies, Wartman and Hellerstein (1948) found anterior infarction in 72 percent, posterior infarction in 28 percent but multiple infarcts in 41 percent. Half the anterior infarcts and a quarter of posterior infarcts also involved interventricular septum. Right ventricle infarc rarely occurs alone. There were 4 out of 160 cases. Saphir *et al* (1935) had observed one instance of right ventricular infarction in their 34 cases of myocardial infarction. Whether this is due to rich coronary anastomosis as suggested by Prinzmetal *et al* (1948) to the relatively smaller myocardial mass of right ventricle or other factor is unknown. Lowe and Wartman (1944) have reported a trial infarct usually involving right arterial appendage simultaneously with ventricular infarction in 17 percent cases of ventricular infarction.

CARDIAC ANEURYSM

Cardiac aneurysm was met with in 20 hearts or 7 percent of the 268 cases of infarction. There were 12 males and 8 females ranging in age from 46 to 80 years. Cardiac aneurysm was associated with anterior infarction in 12 cases, anterior and posterior in 5 cases and posterior infarction in 3 cases.

The frequency of cardiac aneurysm has been reported as high as 38 percent or 57 out of 150 cases by Appelbaum and Nicholson (1935). According to Wood (1951) the figures vary from 10-30 percent according to definition of aneurysm in the published necropsy figures.

CARDIAC RUPTURE

Cardiac rupture was found in 7 hearts or 2·6 percent of 268 cases of infarction. The septum was ruptured in 2 cases and left ventricle in remaining 5 hearts.

Myocardial softening may result in rupture of heart. Martland (1939) found rupture among 7 percent of 318 cases of coronary occlusion. Friedman and White

(1944) found 10 cases of rupture or 9·4 percent in 105 autopsied cases of myocardial infarction in a large general hospital, while Jetter and White (1944) found 16 instances of rupture or 73 percent out of a total of 22 autopsied cases of myocardial infarction in mental institutions. The implication is that combined activity by mental patients with unrecognized myocardial infarction was an important factor in causing rupture of heart.

Rupture of the intraventricular septum is seen less commonly compared to the left ventricle. Edmondson and Hoxia (1942) had observed 13 instances of rupture of septum compared with 56 of ventricle.

NATURE OF LEISION IN CORONARY ATHEROSCLEROSIS

The most conspicuous feature of 'normal' coronary arteries is the changes with age in the histological appearance. This was reviewed by Minkowski (1947) and recently described by Levene (1956).

While opinion has not been unanimous, it is generally accepted that the so called fatty flecks or streaks of arteries are the early leisions of atherosclerosis. While some of them undoubtedly retrogress and may leave minute fibrous plaques devoid of lipids, others show advance fibrous proliferation in their superficial layers, while there is concentration of lipid filled foam cells in their deeper parts. Many of the deeply placed foam cells disintegrate and a pultaceous mass of lipids and necrotic debris is formed. In this atheromatous pocket numerous crystals of cholesterol are precipitated. The atheromas of coronary arteries, more than those found in any other vessels, are subject to secondary vascularization. These minute vascular channels may rupture and cause a haemorrhage into an atheroma with the formation of a hematoma and consequent distortion of the plaque. This may cause occlusion of artery or precipitate thrombosis formation.

Dugid (1946, 1948) has drawn attention to two different forms of coronary atherosclerosis involving different pathological processes although they may present similar histological pictures, which are often indistinguishable (1) Atherosclerosis may arise by the deposition of lipids or lipid bearing cells, advanced leisons being formed by successive deposits of foam cells heaped one on top of the other with occasional layer of endothelial cells laid down in between. Atheromatous foci are produced by break down of older and more deeply buried deposits. (2) The other leisons which we classify atherosclerosis are infact organized or partly organized mural thrombi. When mural thrombus forms in coronary arteries it becomes covered with endothelium so that it is incorporated in vessel wall. Most mural thrombi are very small consisting of no more than microscopic layer of fibrin, but these when laid down repeatedly one on top of another can give rise to considerable thickening of vessel wall. After a succession of mural encrustatious have been laid down, the two way capillary vascularisation develops.

We have interested ourselves recently in the histochemical studies in experimental atherosclerosis to study the changes which favour the deposition of cholesterol at the site of the intima. The work is in progress and it is yet too early to draw any conclusions or apply this knowledge to atherosclerosis of coronary arteries.

SUMMARY

1. Hearts from 1284 consecutive autopsies were examined by Schlesinger technique.
2. Coronary occlusions were met with in 342 or 26·6 per cent hearts.
3. The hearts from persons under the age of 20 years showed no coronary occlusions. The maximum incidence was between 51-80 years.
4. Males predominated but difference was less marked beyond the age of 50 years.
5. 46·6 percent had only one occlusion and the remaining had two or more occlusions.

6. Occlusions occurred most commonly but not predominantly in anterior descending branch of left coronary artery 41·6 percent and least in left circumflex coronary artery 34·8 percent.
7. 25·6 percent of heart, with coronary occlusion showed no infarcts and 5·2 percent of hearts with myocardial infarction did not show coronary occlusion.
8. Anterior infarcts were commonest and next common infarcts of the posterior wall. Infarcts of the right ventricle and right auricle are extremely rare.
9. Cardiac aneurysm was next with in 7 percent cases and rupture in 2·5 percent of infarcted hearts.

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2. J. C. BANERJEA (Calcutta) : *Management of Acute Myocardial Infarction.*

Once the diagnosis of acute myocardial infarction has been made no time should be lost in relieving the agonising precordial pain by intramuscular administration of a solution of morphine sulphate gr. 1/4 and atropine sulphate gr. 1/100. If there be no marked relief in half an hour, morphine is to be repeated in the same dose. If the radial pulse is imperceptible, extremities are cold and livid, blood pressure is low, morphia is not likely to be absorbed quickly by the hypodermic or intramuscular route and so it should be administered intravenously in the dosage of gr. 1/6 morphine sulphate dissolved in 5 ml. of distilled water, at a slow rate in course of 3-5 minutes. In presence of associated emphysema and chronic bronchitis morphia should be avoided and pethidine hydrochloride 100 mgm. is given hypodermically. The patient is then propped up in a comfortable position to lessen the burden on the weakened left ventricle and prevent the occurrence of pulmonary oedema. In case he is unconscious or in state of shock, recumbent posture is advised with the foot end of the bed slightly raised if necessary. Dyspnoea and cyanosis are indications for the administration of oxygen by the B.L.B. mask, if available, or by the intranasal catheter at the rate of 5 litres per minute. To avoid irritation of the upper respiratory tract, Oxygen should be bubbled through warm water in a Woulffe's bottle. The above measures would bring about relief of the pain and associated dyspnoea if any. If however the pain is persistent or recurrent, morphia or pethidine injections are repeated, injection of morphine sulphate may have to be administered in twenty four hours.

In cases with acute peripheral circulatory failure with blood pressure as low as 80/60 mm. Hg., pholedrine 20 mgm. in 1 c.c. may be injected slowly intravenously every 2-4 hours, the blood pressure must be recorded every half an hour. Nor-adrenaline 2 mgm in 500 c.c. of 5% glucose solution by slow intravenous drip is also useful. Desoxycorticosterone acetate should not be used as it is likely to produce sodium retention and pulmonary oedema. Adrenaline is also contraindicated for fear of causing ventricular tachycardia and fibrillation.

If blood pressure does not improve, intravenous transfusion of 250 c.c. of sodium free plasma, if available or sodium free dextrose may be given. The risk of increasing the burden on the weakened left ventricle and precipitating pulmonary oedema has to be borne in mind. The occurrence of the latter complication should be combated by the administration of a mercurial diuretic such as mersalyl 1 c.c. intramuscularly.

Arrhythmias, apart from extrasystoles, are not frequent. Ventricular tachycardia, varying grades of heart block and auricular fibrillation have been observed in a few cases. The routine oral administration of quinidine in daily doses of grs. 20-30 for the first two weeks to prevent the onset of auricular fibrillation, ventricular tachycardia and ventricular fibrillation is not considered necessary. But it should be used promptly in adequate dosage whenever such arrhythmias appear. In case of varying degrees of heart block, 1/2 c.c. of adrenaline in aqueous solntion 1 in 1000 must be injected intramuscularly, to be followed by 1 c.c. of adrenaline in oil by the intramuscular route. This line of treatment should not be withheld for fear of precipitating ventricular fibrillation. Digitalis is not indicated unless there is evidence of congestive cardiac failure associated with systemic venous and hepatic congestion.

Use of anticoagulants :

Recently much emphasis has been laid on the routine use of anticoagulants for a period of 3-4 weeks after the onset of myocardial infarction, for the purpose of preventing the spread of the thrombotic process and the occurrence of embolic phenomena. About ten per cent of the deaths in myocardial infarction may be attributed to thrombo-embolic complications. This experience is contrary to that of the workers of the Western countries.

If facilities for frequent estimations of prothrombin time are available, anticoagulants may be used, particularly in cases where the patient has extensive myocardial damage, is obese, has thrombo-phlebitis or phlebothrombosis in the legs, gives history of recent attacks of myocardial infarction, or of congestive failure or has developed auricular fibrillation and heart failure. Of the various anticoagulants heparin, dicoumarol, tromexan, the last is preferred because of its ease of administration by the oral route and its rapid excretion. Tromexan may be used in the initial stage in the following doses :—

1st twenty-four hours :	600 mgm. immediately. 600 mgm. after twelve hours.
2nd twenty-four hours ;	300 mgm. thrice a day.

From the third day onwards a maintenance dose of 300-600 mgm. a day for 4 weeks is given according to the prothrombin time which is to be kept at 35-40 seconds (normal being 15-20 seconds).

SUBSEQUENT MANAGEMENT

Rest. Bed rest is to be continued for six weeks. During the first week rest should be absolute. A nurse or attendant should change the posture of the patient in bed from time to time, wash him and feed him. The number of visitors is to be strictly restricted to ensure mental rest. After the end of the first week the patient should be encouraged to move his legs in bed, by the end of the third week sitting up in bed for a few hours is allowed. At the end of the fourth week he may be allowed to sit in a chair by the bed side at first for 15 minutes once a day, then twice a day, then for twenty minutes twice a day—thus gradually increasing the time till he is able to sit for 4-5 hours a day without any discomfort.

Sleep : It should be ensured during the first few days by the hypodermic injections of morphine, pethidine or omropon if necessary and later on by the oral administration of phenobarbitone grs. 2-3 at the bed time.

Care of the bowels : The bowels need not be moved for the first two to three days after which an enema may be given. Thereafter four drachms of milk of magnesia with or without half an ounce of liquid paraffin may be prescribed at night to maintain a soft stool. The use of a bed side commode is preferable to bed-pan.

Diet : During the first two to three days, the presence of nausea, vomiting and abdominal distension interferes with the proper feeding of the patient. Glucose water 5% and skimmed milk about 4-6 ozs. are given at 2-3 hourly intervals. Excess of orange juice should be avoided because of its high potassium content. The total fluid should not exceed 50 ozs. in the initial stages. Gradually a diet of about 1000 calories consisting of skimmed milk, soft rice, boiled fish and mashed potato is given. The sodium content of the diet should not exceed gm. 1, otherwise congestive cardiac failure may set in. Gradually the caloric value is increased to the normal requirement except in cases of obesity. Articles of diet rich in cholesterol and animal fats should be avoided in cases where the serum cholesterol and lipoproteins are high.

CORONARY DILATORS

Drugs such as theophylline-ethylene-diamine, 0·1 gm. t.d.p.c. or Khellin 25 mgm. 3 or 4 times daily after meals by mouth have been used to increase the coronary blood flow and help the early establishment of collateral circulation. The results are not uniformly satisfactory. Besides Khellin gives rise to unpleasant symptoms in many cases viz. flatulence, marked constipation, nausea and hiccough. Pentaerythritol tetranitrate in doses of 10 mgm. t.d.s. has been found to be more effective. It has to be continued for a period of at least four months.

Smoking : It should be completely stopped whenever possible. It is liable to induce coronary spasm in many patients and cause an increase of heart rate and blood pressure. In case it can not be stopped it should be limited to the use of five cigarettes a day.

After care : At the end of the sixth week the patient is allowed to walk a few steps a day and the walking is gradually increased according to the strength of his leg muscles and without producing any sense of precordial discomfort. By the fourth month he may resume light duties. The patient should however have a thorough check up every three months for a year and thereafter every six months for the next two years, consisting of clinical, radiological electrocardiographic and biochemical investigations to assess the cardiovascular status and his fitness for continued and efficient work.

MANAGEMENT OF ACUTE MYOCARDIAL INFARCTION

The immediate objective is the relief of pain and shock. For this purpose morphine sulphate in dosage of gr. ¼ with atropine sulphate gr. 1/100 is injected hypodermically once the diagnosis of acute myocardial infarction is made. It may be repeated after half an hour in case there is no relief of pain. Morphine gr. 1 may be necessary in 24 hours. In case of associated shock and collapse intravenous administration of morphine gr. 1/6 slowly is recommended. In cases with emphysema and cyanosis injection of 100 mg. of pethidine hydrochloride is advocated.

Importance of propping up the patient and administration of oxygen with B.L.B. mask specially in cases with dyspnoea and cyanosis are emphasised. Recurrent pain is also an indication of oxygen therapy.

Peripheral circulatory failure is to be combated with injection of pholedrine or intravenous drip of nor-adrenaline in 5% glucose solution in distilled water.

Desoxycorticosterone acetate and adrenaline are contra-indicated.

In case of persistent shock, sodium free plasma or sodium free dextrose by intravenous drip may be given. The precipitation of pulmonary oedema is to be borne in mind and may be combated with injection of mersalyl.

Routine administration of quinidine to prevent arrhythmia, is not favoured which, however is to be given in cases with auricular fibrillation, ventricular tachycardia and fibrillation. Injection of adrenaline 1/2 c.c. is to be given in cases with varying degree of heart block.

Digitalis is indicated only with advent of congestive failure.

Anticoagulants may be used in obese subjects especially with thrombophlebitis or phlebothrombosis or cases with congestive failure, auricular fibrillation or with history of recent attack of myocardial infarction provided facilities for estimation of prothrombin time are available. Tromexan is the drug of choice.

Subsequent management consists of bed rest for six weeks. It should be absolute for 1 week and then the patient is gradually allowed to sit on a bed side chair at the end of the 4th week.

Sleep is ensured initially with preparations of opium and then with barbiturates.

Bowels are to be moved after 2/3 days with an enema and later on with milk of magnesia and liquid paraffin. A bed side commode is preferred to a bed pan.

During first few days diet should consist of glucose, skimmed milk and orange juice. The last should be avoided in excess due to high potassium content. Diet is gradually increased to skimmed milk, soft rice, boiled fish and mashed potato. Sodium in diet should not exceed 1 gm. a day. Articles rich in cholesterol and animal fats are to be avoided in cases with high serum cholesterol and lipoproteins.

Pentaerythritol tetranitrate is preferred to theophylline-ethylene-diamine or Khellin as coronary dilators.

Smoking is to be restricted to 5 cigarettes a day in case complete abstinence is not possible.

After care: After 6 weeks—patient is gradually allowed to be up and about till he may be permitted to resume full duties at the end of 6th month.

He is to be checked up every 3 months for 1 year and then every 6 months for next 2 years.

3. DR. A. K. BOSE (Calcutta): *Prognosis in coronary arterial diseases.*

INTRODUCTION

Pathological condition of the coronary arteries may be produced by such varied causes as rheumatic fever, syphilis, other infections, periarteritis nodosa, thrombangeitis obliterans, coronary embolism etc.; but by far the commonest condition is produced as a result of atherosclerosis of the coronary arteries and this discussion will be mainly limited to this aspect.

Coronary atherosclerosis is revealed clinically by three main sets of symptom complexes.

(i) Angina pectoris including coronary insufficiency which may or may not pass into,

(ii) Coronary thrombosis and myocardial infarction, and

(iii) Congestive cardiac failure of slow onset as the main presenting feature as a result of long continued, non-acute coronary pathology, but not associated with hypertension.

I. *Angina Pectoris and Coronary insufficiency.*

The average life expectancy is between five and ten years, but in about 10% of cases it may be as long as twenty years. Women generally have a better prognosis than men, due obviously to the nature of work they have to perform respectively. Prognosis is worse in young subjects, below 40, possibly due to less formation of collateral circulation. E.C.G. abnormalities found at rest, tend to influence the prognosis adversely.

There are evidences to believe that when the beginning is very insidious the prognosis is better. This seems likely as it has been found that when the blood supply to any area is threatened, anastomosis between the branches of the coronary artery develops more abundantly.

Angina Pectoris associated with syphilis has a more serious prognosis than when associated with severe coronary diseases, this is particularly so when the pain occurs at night.

When a young person develops angina as a result of aortic leak it is particularly grave. When there is a remedial contributing cause, such as anaemia and hyperthyroidism the outlook is better and the condition may even be cured.

Danger of sudden death, however, is always there and it bears no definite relation to severity of symptoms and its frequency. It may, however, be said in general that the fatal issue is more likely to occur when the symptoms are severe. Sudden death occurs in about 10-15% of cases. It is however quite common to find cases living for 10-15 years or even longer. In some such cases death occurred, because the patient forgot certain definite measures which apparently prevented death during previous years.

Family history often seems important in the reciprocal way in prognosis. This may be due both to actual pathological changes related to genetic factors as well as to temperament.

25% of cases develop myocardial infarction. Pronounced hypertension or cardiac enlargement, previous myocardial infarction and heart failure would tend to shorten the period of survival but there are many exceptions.

In a small percentage of cases the symptoms may disappear temporarily or even permanently, probably as a result of either clinical or sub-clinical attack of myocardial infarction which had made the offending area of heart muscle insensitive as a result of "death" and fibrosis.

Though, therefore, one could not be dogmatic regarding the prognosis in angina pectoris, an individual case may be guided through a useful life of long duration.

II. *Coronary Thrombosis and Myocardial Infarction.*

The prognosis could be considered conveniently from the acute phase and a long term phase of the condition after recovery.

(a) *Acute phase* : Barring those cases that cause sudden death, the immediate mortality rate could be considerably diminished by the adoption of appropriate methods.

Mortality rate on all diagnosed cases have been determined to be about 25% with no special attention.

16·5% is the rate with semi-starvation diet at the initial period. Semi-starvation diet for the first 48 hours, followed by about 600 calories on subsequent days decreases the mortality rate considerably.

It is 13% with anticoagulants—congestive failure increases the incidence of phlebothromboses, which is definitely diminished by anticoagulants. Massive pulmonary embolism is not, as a rule, due to mural thrombosis.

It may be further brought down to 10% with low sodium diet and quinidine in appropriate cases. Ventricular fibrillation occurs in about 10% of death; administration of quinidine/pronestyl with the onset of ventricular ectopic beats or tachycardias would tend to improve the prognosis as far as this complication is concerned. Persistence of any type of irregularity adversely affects the prognosis.

Death rate is even less than 10% with drugs to support during the phase of acute hypotension.

Mortality rate is much lower during the first attack, this will appear more so when more cases of minor nature will be clinically detected than what is being done to-day.

When infarction is limited to superficial layer of myocardium, a fact that could be determined by E.C.G., prognosis is better, even if it is more extensive, because not only the mechanical disadvantage is less but also because anastomosis is more conspicuous in the superficial layer of the myocardium.

Anterior or Posterior infarction did not matter much, but involvement of the septum, multiple lesions and extensive necrosis are bad omens. Indeterminate pattern in E.C.G. perhaps indicate in the same unfavourable way. High rise of temperature, leucocyte count and sedimentation rate and their persistence generally indicate more extensive infarction. Greater the fall of blood pressure, worse is the prognosis. Hypertension does not seem to have any adverse prognosis unless the heart was enlarged or cardiac failure was more frequent as a complication.

Cardiac rupture occurs in less than 10% of fatal cases. If rupture does not occur during the first few weeks the prognosis is fair. Less than 10% of ruptured hearts are due to an old ventricular aneurysm.

It has been noted that hypertension that persists after infarction is more likely to cause rupture than when there is normal or subnormal blood pressure. Cases with ruptured septum may live for months even years, though the prognosis generally is poor in these cases.

Even first attack, below the age of 40 is particularly fatal; but if such young persons recover they have a much better prognosis. Mortality rate is greater again beyond the age of 60. Subsequent attacks naturally carry a more severe prognosis and this is particularly so in patients who developed chronic congestive failure as a result of the past attack. Outlook of survival is unfavourable when the pain persists almost unabated after the first twenty-four hours, even with proper treatment with opiates.

Development of acute pulmonary oedema is to be regarded as an unfavourable complication, particularly if it persists beyond a few days.

Diabetes mellitus adversely affects all types of cases.

Generally speaking the outcome of an attack of acute myocardial infarction is unpredictable. A patient may suddenly die due to some unexpected complication while apparently he was making good recovery, on the other hand, critically ill patients may recover to have many years of useful life.

(b) *After recovery from the acute attack*:

The patient's outlook is much more favourable than was formerly recognised. At least 25% survive for more than ten years and 50% for more than five years or longer. The younger the patient the longer was the period of survival. There are instances of survival for fifteen years, even in the presence of venticular aneurysm. There are occasional cases surviving for twenty-five years or longer.

It is not intended to convey the idea that the condition is not serious, but to impress on all concerned that an individual case may not be enveloped in a sense of excessive pessimism. It is necessary that the patient should not feel that a "heart attack" means either death or invariable short life of invalidism.

In a majority of cases, unfortunately, activity has to be considerably curtailed due to appearance of such symptoms as angina pectoris, dyspnoea and general weakness. About 2/3 belong to this category, the rest are the asymptomatic group; but the total number of cases that can carry on a fairly active life is much larger than the purely symptomatic group, because many with angina are also included in this.

One third of those that developed angina survived for more than ten years.

Generally there is a significant lowering of the level of blood pressure but in some cases it may rise to the prethrombotic level. When there is a post thrombotic hypertension cardiac failure is likely to occur and the final prognosis becomes less favourable.

Dyspnoea that developed during the acute phase disappears in the majority of cases that survived, but in those in which it remained the outlook was poorer and none of them survived a period of 10 years and died of congestive failure even with all necessary precautions. Cardiac enlargement or its absence influences the prognosis in the same way as does dyspnoea.

In about 20% of cases E.C.G. returns to a normal pattern in about a year's time and denotes a more favourable outlook.

After recovery there is always the possibility of a subsequent attack which will naturally endanger the prognosis.

Finally one must impress on the great modifying factor on the prognosis of the patient's healthy optimism and the wise and tactful management of a practical but sympathetic physician.

III. *Congestive Cardiac failure as the presenting symptom.*

The incidence of these cases is considerably less than the other two, nevertheless it is a recognised clinical entity. Prognosis is not at all unsatisfactory, provided the cases come under observation before more than minor degree of enlargement of the heart had taken place.

As the incidence of this group is maximum between the ages of 50 and 60, such patients could be guided through a fairly long and useful life of ten to fifteen years.

ANALYSIS OF ONE HUNDRED CASES UNDER AUTHOR'S OBSERVATION

Youngest	32 years (non-diabetic)
Oldest	85 years
Male	93
Female	7
Anterior infarction	58
Posterior infarction	42

Almost half gave history of Angina Pectoris—46

Seventy-five were first attack cases.

Longest period of observation was twelve years and with two attacks.

52 cases lived for more than five years and a large number amongst them are still living. Amongst those that died many were guilty of disregarding well recognised precautions.

Associated diabetes was present in 22 cases.

I. BIOLOGICAL CONTROL OF PESTS

Section of Agriculture jointly with the Section of Zoology & Entomology

Chairman: DR. E. S. NARAYANA.

1. R. P. CHAUDHURI (Izatnagar): *Role of Viruses in the Biological Control of Insect Pests.*

It was Von Prowazek who first published in 1912 the results of experiments on any virus disease of insects. He showed that the healthy silkwoms (*Bombyx mori*) could be infected with the bacteria-free Berkefield filtrate of grasserie material. Then in 1913 two other virus diseases, one affecting bees (*Apis mellifera*) and the other affecting Gypsy moths (*Porthetria dispar*), were described separately by White, and Glaser and Chapman respectively. So far some 48 species of insects in 19 families under Coleoptera, Lepidoptera, Hymenoptera and Diptera are known to be susceptible to virus diseases. Smith has recently (1956) recorded 26 viruses affecting 22 species of insects. With the exception of the bee paralysis which affects adult bees all the known insect viruses are found to have produced diseases on larvae only.

Insect viruses can be divided into 3 main groups viz. polyhedral viruses, granulosis viruses and viruses producing no intracellular inclusions. In case of polyhedral viruses certain tissues of the diseased insects become filled with polyhedral crystals. These crystals contain virus particles in them. Those polyhedral viruses which multiply inside the cell nucleus are known as nuclear type and the others which multiply in cell cytoplasm are called cytoplasmic type of polyhedral viruses. The diseases produced by these two groups of viruses also differ. In granulosis viruses the characteristic inclusion consists of an outer granule or capsule within which is usually another granule containing the virus particle. The multiplication of the virus appears to take place in the cell nucleus. The disease caused by this kind of viruses closely resembles the nuclear type of polyhedrosis diseases. In the 3rd main group of viruses there are no crystals, granules or any other intracellular inclusions. The virus particles occur freely in certain tissues of affected insects.

Though certain insect viruses may affect a wide range of hosts in most cases a specific virus or a strain of the virus is confined to a given species of insects. In nature the virus spread from insect to insect through the mouth from eating of food contaminated by the diseased insects, the disease can also be transmitted by inoculation. In some cases viruses have been found to have survived in the adults and transmitted through the eggs to the succeeding generations of insects.

Most of the insect viruses so far studied appears to have possessed some advantages over the orthodox kinds of insecticides for the control of insect pests. These advantages are (1) the selective nature of the virus that kills the pest but does not affect the beneficial insects, (2) the persistency of these viruses far exceeds that of any insecticide, (3) the self-propagation of viruses in the insect colonies and (4) the transmission of viruses through the eggs to successive generations of insects. The practical difficulties which must be taken into consideration when, using any virus for the control of insect pests are—(1) the production of a large quantity of infectious material necessary for field work cheaply and easily, (2) the selection of the virus, for if the disease larva is a thin walled sack-like filled with the highly infectious fluid it is likely to be more successful than when it is dried and desiccated, and (3) the chances of success are greater if the insect pest in question feeds openly on its food that can be contaminated with the virus.

The granulosis virus disease of white butterfly caterpillars possesses all the required characteristics of an ideal virus disease for the control of this insect. The viruses that have been tried in the field against two insect pests, namely, lucern caterpillars (*Celias curytheme*) in California and Pine sawfly (*Neodiprion sertifer*) caterpillars in Canada, have no doubt met with some success. However much more studies will have to be carried out before we will be able to decide whether or not some of these viruses can be used effectively for controlling insect pests.

2. SARDAR SINGH (Ludhiana) : *Twenty years of woolly aphis control with Aphelinus mali.*

Woolly aphis *Eriosame lanigerum* Hausman is one of the important exotic pests that have gained entry into and successfully established themselves in this country. It was first noticed at Conoor (South India) in 1889 and in the Kulu valley (Punjab), in 1909. It is a specific pest of apple trees in this country. In the middle thirties the incidence of this pest in the apple orchards was very heavy and the apple growing industry in the Punjab faced a very serious problem. Spraying of the aerial forms with nicotin sulphate and use of PDB against the root forms were found to be successful in suppressing its population, but such insecticidal measures were not taken up readily by the fruit growers. The parasite—*Aphelinus mali* Hald. of woolly aphis was introduced in Kulu valley in 1937 and it quickly established itself. It was found to be a specific parasite of woolly aphis in the Punjab. The parasites attack wingless adults and 4th stages nymphs of the woolly aphis commonly and 3rd stage nymphs rarely. It has not been noticed to infest winged adults and 1st and 2nd stage nymphs. At the peak of its activity a female may parasitise about 220 individuals. The parasitised nymphs lose their white waxy threads and become deep black in colour. On an average the adult parasite lives for 718 days, and completes its life cycle in 20-33 days in March-June and 11-18 in June-October. It hibernates as a grub in the body of its host from November to February. It may pass through fifteen generations.

In comparison woolly aphis is viviparous, parthenogenetic and multi-brooded. It may viviposit throughout the year though at varying rates.

Aphelinus mali has successfully suppressed the population of woolly aphids during the last 20 years in the Kulu valley and very few knotty trees, a typical after-effect of woolly aphis attack, are met with at the present time. Total extermination of pest by the parasite is neither claimed nor is possible. Part-time services of a 'beldar' are necessary for maintaining a dozen and a half wire-gauze cages of 4′×2′×2′ size established in different orchards in the valley. These cages are used for planting twigs of apple harbouring the parasitised and healthy woolly aphis, so as to keep a nucleus population of the parasite unmolested from the predators during summer and action of Diesel oil emulsion as a dormant spray against sanjose scale during the winter.

These twigs require irrigation twice a week and their number is to be augmented every fortnight by freshly cut infested shoots. This free service afforded by the Punjab Agricultural Department is highly appreciated by the growers whose orchards have been saved from the ravages of this international pest of apple trees.

PHYSIOLOGY OF HYPOTHERMIA

Chairman : PROF. INDRAJIT SINGH, Agra.

Section of Physiology

(i) Hypothermia

1. M. K. RAYCHOWDHURY : *Extra corporeal circuit apparatus to produce hypothermia.*

Hypothermia in an animal is induced by cooling the body which has got certain disadvantages. A simple apparatus is devised to cool the blood in extra corporeal circuit and then introducing it in the circulatory system. The criteria for the suitability of assembly for hypothermic purpose are decided on following points :

(1) rate of cooling and rewarming can be adjusted,
(2) the circuit and the capacity do not act as a load on the heart of the animal before or during cooling or during rewarming,
(3) it should be simple and economical,
(4) it should be portable,
(5) circuit itself is a continuous unjointed one and does not promote clotting,
(6) it can be sterilized, if needed for clinical uses.

Description of apparatus :

A Cu-vessel of 1′×1′ was taken in which a polythene tube of 15 c.c. capacity was introduced and the two ends of the tube were used to connect with the artery and vein of the animal respectively. The cooling agent was brine and ice mixture contained in a wide glass jar from which the cooled brine was taken to Cu-vessel by a A.C. Pump. The height of the column of the cooled brine in the Cu-vessel can be adjusted by an ordinary glass tube introduced from the bottom of the vessel with a view to influence the rate of cooling of the polythene tube by simply lowering or raising the glass tube within the Cu-vessel. The cooled brine after attaining a desirable height within the Cu-vessel overflows to the brine container through the adjustable glass tube, and in this way cooled brine circulation is maintained on. It is to be noted that the temperature of the cooled brine within the Cu-vessel always remains a little higher than that of the brine vessel since the dissipation of heat takes place while the cooled brine traverses from the brine vessel to the Cu-vessel and also from the walls of the containers.

2. S. R. MAITRA : *Effect of hypothermia on heart rate, blood pressure and respiration.*

Hypothermia was produced by extra corporeal arterio-venous circuits in cats using ether and urethane as anaesthesis and 1 c.c. of 1/10 Heparin was used as non-coagulant. *In vitro* experiments were done, to observe the influence of rate of cooling of the fluid while the rate of flow of the fluid remained constant. Comparing the results *in vitro* and *in vivo* experiments the effects of lowering of temperature and gradual warming up are studied on pulse rate, blood pressure and respiration.

In analyzing the results *of vitro* and *vivo* experiments, it appears that in the former with constant rate of flow, the rate of cooling differs in different volumes of fluid taken. But this relationship is not observed in vivo experiments, because the heart rate and amplitude become gradually slower as the hypothermia proceeds on and the rate of blood flow is slowed progressively. Heart does not follow Starling's law here. Initially the rate of cooling is rapid but becomes relatively slower in course of cooling. In some animals the thermo-regulation is rapidly overcome by the process of cooling than in others. Blood pressure and pulse rate correspondingly slowed with gradual fall of body temperature. The respiration varied but not identically. Thus initially with rectal temperature at 32°C the blood pressure was 90 mm. of Hg, the pulse rate 155, and after 240 minutes, when temperature was lowered further, the rectal temperature came down to 26°C, the blood pressure 70 mm. of Hg. and the pulse rate to 75. On rewarming at this stage both blood pressure and pulse rate gradually increased with the rise of temperature and pulse rate rose more than normal as normal temperature. Respiration also varied but not identically.

3. P. B. SEN (Calcutta) : *Effect of hypothermia on blood sugar.*

We have measured the sugar concentration in blood during precooling, cooling and rewarming stages. The purpose of this investigation was to study the effects of anaesthesia on those produced by cooling. Sugar tolerance tests have also been done. From these observations, it may be stated that anaesthesia, used here, increases the blood sugar concentration upto a certain level. But during cooling of the same animal, this level increases considerably and remains so. During rewarming this picture is not obtained. Blood sugar concentration is gradually lowered. Sugar tolerance curves (by glucose) in precooling stages show that glucose utilization is continued. But this is not observed when the animal is cooled to 25°-26°C. The sugar tolerance curves are suggestive of lack of glucose utilization. Whether such changes are due to defects in glucose mobilization or utilization associated or not with insulin function or else are under study.

4. R. B. ARORA (Jaipur) : *"Use of drugs in the prevention of ventricular fibrillation in hypothermic drugs."*

Cardiac failure in the form of ventricular fibrillation is the usual outcome of experiments where the body temperature is sufficiently lowered in homiethermic animals (1, 2). The unpredictable onset of fibrillation at degrees of hypothermia used in cardiac surgery represents a considerable hazard in the application of this procedure, and the elucidation of factors involved in the development of fibrillation during hypothermia has become a matter of renewed interest. On account of the reduced blood pressure and increased blood viscosity of the hypothermic state, an inadequate blood through the coronaries has been considered as the causation factor but convincing evidence has been presented to the contrary (3-7). But whatever is the exact physiopathologic mechanism underlying the production of ominous ventricular rhythms, it is obvious that effective means of preventing ventricular fibrillation or of converting it to normal rhythm must be found if the use of hypothermia were to be made safe (8).

Since antiarrhythmic property has been appertained to cinchona alkaloids, antimalarials, local anaesthetics, alkaloids of Rauwolfia serpentina and some indigenous drugs (9-17) it was considered expedient to determine if these compounds also exhibit the property of preventing cardiac rhythms in the hypothermic phase of dogs.

Materials and Methods.

30 adults (18) mongrel dogs of both sexes were used weighing between 6-20 Kg. Sodium Nembutal intravenously 30 mg/Kg. was used as anaesthetic. 15 of them received the drug to be tested; and the rest were used as control. The dogs were then clipped and immediately immersed in water at a limp of 1°C. Pure oxygen was administered through an intracheal tube. The tube being smaller than the trachea, expiration occurred around it, no rebreathing system therefore was necessary.

When the body temperature fell to 29°C the dogs were removed from ice water mixture. They continued to cool another 3 to 5 degrees, and maintained this temperature as long as six to eight hours. Shivering was next a problem if the dog was immersed in the ice water soon after receiving Nembutal. Most dogs cooled in less than an hour and many of the smaller animals cooled in half an hour. This rapid cooling was considered an advantage over the longer times repeated by others who cooled the animals in air (19, 20, 21, 22) or between blankets containing cold solution (23) certainly the dog was hypothermic.

II. Ventricular fibrillation by focal cooling:—

All experiments were performed on dogs anaesthetised with Nembutal. Chest was opened under artificial respiration and pericardium was appended. In these experiments vagi were served in neck and the electrocardiogram was registered in lead II.

The cooling was done with a test tube filled with ice and the area cooled was about one square centimeter. In most experiments area cooled was located approximately in the centre of the right ventricular surface, away from the 'central region' near the coronary. In the experiments in which left ventricle was cooled, the thermode was applied at the 'left cardiac border' slightly positively and above the apical area. This resulted in the production of ventricular fibrillation. Effects of drugs to be tested were seen by its pre-administration via jugular vein. In all experiments electrocardiogram was taken from the beginning of the cooling to a few seconds after its termination.

5. D. P. SADHU (Calcutta): *Hypothermia.*

Adjustment to hypothermia has always raised a problem in the cold climate and especially so in the arctic expeditions. The problem of hibernation in poikilotherms and even in some mammals has intensified the studies on hypothermia, besides its surgical uses in operation on heart and other highly vascular organs. Hibernating animals have a very low energy metabolism during the process of hibernation at a cold ambient temperature, while the homeotherms have usually an increased energy metabolism when exposed to cold environment. This fundamental difference in the two sets of animals has given an impetus to the study of respiration of tissues under *in vitro* hypothermic conditions. In the nonhibernators the effect of hypothermia on tissues is more than counter-balanced by the metabolism-raising effects of cold-induced hypersecretion of adrenal, thyroid, and other endocrines, while in the hibernators the direct effect of hypothermia on the tissues *in vitro* remains the predominant factor in the induction of the hibernating process. (Layman and Chatfield, 1950; Woodruff, 1941; Hereux and Hart, 1954; Ruhe and Horn, 1953; Romosoff and Holady, 1954).

Hibernation, therefore, raises two problems, one of the thermostatic control and the other of the direct effect of hypothermia on the body tissues. It will be of interest to intensify the studies of thermo-regulation especially in the hibernating mammals. Decrease of energy metabolism with respect to cyclophorase system and other enzyme activities has to be studied. Problem of adrenal and thyroid reaction to low temperature has to be tackled.

(ii) Neurophysiology

1. D. P. SADHU (Calcutta):

Neurochemistry forms a basis for the proper understanding of Neurophysiology. The Nissl chromatic stain clearly reveals cell bodies of neurones, nuclei of astrocytes, oligodendrocytes, microglial cells and capillary endothelium, but the amount of unstained intercellular substance is very large. The use of various metallic impregnation methods selectively reveal the complete structure of each of its cellular species. A reduced silver preparation stains axis cylinders and intracellular neurofibrils of neurons and the network of axonal and dendritic arborizations constituting the intercellular *Neurophil,* i.e., the plexuses of axons and dendrites generated by afferent fibres and by protoplasmic and axonal processes of both local distant cortical neurons. Astrocytes are demonstrated by gold chloride sublimate method of Cajal, while the oligodendroglia and microglia are stained by Penfield's combined silver carbonate technique.

30% of total cortical volume (isocortex of several species) is occupied by nerve cells including their protoplasmic expansions (space occupied by cells alone being 5%), 35% is the extracellular compartment and 35% for myelin, blood vessels and neuroglia. Sphingosine base forms a special component of the neurochemical constituents and is responsible for the two elements, cerebrosides and sphingomyelins. The function of these neurochemical constituents is not properly understood, although it is believed that they help in insulation. There is transglycosidation of the spingosine base to cerebroside, which is either galactocerebroside or/ and glucocerebroside. The amount of transglycosidation depends on the presence of galactose in blood and other factors. There is an increase in the amount of the sphingosine base in the phylogenetic scale of evolution along with an increase of lactose concentration in the mothers' milk of the mammalian species. A study of the mechanism of transglycosidation of sphingosine base and its chemical properties are likely to throw light on the neurophysiological problems.

PSYCHOLOGY OF MANAGEMENT IN THE INDUSTRIALISATION OF THE COUNTRY

Section of Psychology & Educational Sciences

Chairman : PROF. S. M. MOHSIN.

1. RAJNARAIN : *Character structure and management.*

The Second Five Year Plan admits that the progress of first five year plan was not quite satisfactory if viewed against the past ground of "levels of capacity and productions", because economic planning extends itself into extra-economic spheres. The paper dilates upon the psychological aspect of planning and addresses itself to managers of industry in the private sector.

The paper first elucidates the role of managers in the world of work in social orders that are tradition-directed, inner-directed, and outer-directed following Riesman's typology of character and society. Since the three orders of societies succeed one after the other, managers have to be prepared to undergo changes. To facilitate the process of adjustment to change, the following propositions are put forward : (1) Managing workers is not an elementary job; (2) management should be trained in managerial techniques; (3) personnel departments in industrial concerns should be organized, if they do not already exist; (4) the personnel psychologist must form a member of the personnel department; and (5) industry should divert a part of its resources to personnel research.

2. DR. W. T. V. ADISESHIAH (New Delhi) :

1. *Introduction.* 'Labour Relations' and 'Industrial Management' are two related but distinguishable fields. The former seeks to achieve greater efficiency and work satisfaction, whereas the latter aims at promoting industrial peace. Since the character of human relationships is an important determinant of industrial efficiency, social factors in industry are of interest to the psychologist.

2. *Group Dynamics.* Recent researches have centred around sociometric patterns of interaction in groups. Factors such as creating work for teams, fitting them together, giving workers a place in the picture of production etc., have proved to be effective in achieving greater productive efficiency.

3. *Worker Need Satisfaction.* The removal of frustration and provision of means to satisfy the physiological and safety needs of workers have today become the key factors in work satisfaction.

4. *Leadership and Industrial Morale.* The scientific assessment of leadership ability, employee orientation on the part of supervisors, organised efforts to influence the attitudes of the workers, and the participation of workers in the common productive effort are indispensable factors in the maintenance of industrial morale.

5. *Conclusion.* It is the accepted principle in Industry today that unity of worker and supervisor in achieving a common aim is the most important single factor in Industry. The changing situation in Industry resulting from the increased use of automatic production will create fresh social and psychological problems.

3. RAMA G. KAMAT :

To establish the proper psychological approach from the side of Management with regard to our industrial development plan, it is necessary that:

1. The administrators, directors, managers and chief executives must have a nationalist background and be perfectly integrated into the philosophical principles of our socialist welfare state.
2. The private sector must obey the trusteeship principles enunciated by Gandhiji, and replace the aim of profit by that of social gain.
3. Where possible, foreign enterprises in vital sectors such as coal, petroleum, tea and coffee must be nationalised.
4. Immediate Indianisation of personnel must be imposed. Only Indians shall be allowed to hold executive posts in industries. Foreigners can work as technical advisers when suitably qualified Indians are not available.

4. A. K. PAL : *Management Participation in Research on Human Problems of Introducing Change in Industry.*

Research on 'Human Problems of Introducing Change in Industry' conducted by 4 teams of executives, time and staff personnel with a psychologist as a consultant on the study helped to bring awareness of the human problems in industry.

Forty members spent three months in study, field visits, (4/5 organizations) and discussions, and each team prepared a report based on their observation and understanding of the situations. Each team studied a specific aspect of the problem —new machine, new method, new personnel and new staff functions.

The salient feature of the studies were discussed. The role of the psychologist consisted largely in acquainting the team members in research methodology and in encouraging various members to explore the situations they observed.

PSYCHOLOGICAL APPRAISAL OF THE CONTEMPORARY EDUCATIONAL TRENDS IN INDIA

Chairman : PROF. S. M. MOHSIN.

1. RAJ NARAIN (Lucknow) : *The Psychological Basis of Basic Education with special reference to the principles of Gestalt Psychology of Learning—A Study of Method.*

I have recently had the privilege of reading a dissertation entitled "A critical study of the psychological basis of Basic Education with special reference to the principles of Gestalt Psychology of learning.* The author, an educationist, has attempted therein to interpret the "facts and theories of basic education through the application of the principles of Gestalt Psychology." (p. ii). After having gone through these interpretations, I was left wondering about the methodological problems of attempts like his to explore the psychological foundations of various systems of education—the topic of the present symposium. And I therefore resolved to share with you some of my reflections of the methodology of such studies. Before I present those, I should first summarize for you the findings of the author, as far as possible in his own words.

1. The objectives of basic education are (a) the development of the whole man and (b) the development of a balanced and harmonious society. The goal of education according to Gestaltists is the development of a socially integrated personality. Hence the objectives of basic education and of Gestalt goal of education are nearly the same. (p. 226).

2. Regarding the education of village children, Basic education observes the following principles of Gestalt psychology :

   (*a*) "Life and learning are coextensive processes" is observed for Nai Talim provides education for the whole life.

   (*b*) "Learning by understanding is self-motivated" is observed because in basic education, learning starts with village craft which provides motivation for the child from within.

   (*c*) "Possibilities of transfer abound in learning by understanding" is observed because teachers and administrators report that it is rich in transfer effect.

   (*d*) The principle that child's participation in learning should be obtained is followed in as much as the child is not supplied with knowledge of the Three R's, which he gets through the basic craft and correlation with his social and physical environment.

   (*e*) "Spontaneous learning is the child's normal response to day to day situations" is observed because the child learns in a basic school from whatever he is doing.

   (*f*) "Activity is the predominant behaviour trait of childhood" is observevd for enough activity is provided for the child in basic schools.

   (*g*) "Learning should be goal-directed meaningful response and in response to a need" is observed. (The reason for observance is not explicitly stated).

3. In regard to the curriculum of basic education, the following principles of Gestalt psychology are seen as being observed :

   (*a*) "Both subject-matter and activities as contents of curriculum are essential for the full development of the personality of the children" is observed because basic education emphasizes correct relationship between activity and subject-matter.

   (*b*) "Emphasis should be placed more on activities at the elementary stage and on subjects at the higher stage" is partially observed; basic education does emphasize activities at the elementary stage.

   (*c*) "General education and survey courses harmonise with the nature of of early mental development of the child, the specialized courses are justified when the growth has proceeded sufficiently via differentiation" is observed because basic curriculum emphasises harmony in the contents and favours general education and survey courses at the early stages.

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*By Mukut Behari Lal Khushdil, M.A. (Phil. & Geog.), B.T., submitted for the degree of Doctor of Philosophy of Agra University, 1956.

(*d*) "*Much rather than many should be the pedagogue's curricular watchword*" is *observed because basic education is not overcrowded but rich* in relationships.

(*e*) "Curriculum should be laterally organized, *vertically organized, and organized as a whole" is observed. (Reasons are not explicitly stated).*

(*f*) "Curriculum should be based upon the needs of the child" is partially observed, because the basic curriculum takes into account the different needs of the child, excepting the needs in relation to religious life.

(*g*) "Curriculum should be based upon the needs of the child-in-society" is observed.

(*h*) "Child is a creative organism and as such is capable of creativeness in his expression" is observed for basic curriculum provides for sufficient opportunities for self-expression to the child.

(*i*) "Curriculum should facilitate transfer" is observed.

In addition to the interpretation of objectives, curriculum of basic education and education of village children, the author has observations to make regarding basic craft, basis methodology, and basic teacher. He also offers suggestions regarding three problems of basic education, viz., teaching of English in basic schools, the theory of self-supporting education, and evaluation in basic schools. Since in all these, he has not claimed direct application of Gestalt principles, I shall ignore them.

Even where he has ostensibly "applied" the principles of Gestalt psychology (of learning) to basic education, I would like to raise the following questions in order to assess the validity of his writing :

1. Is not a "system" or school of psychology (or of any other discipline, for the matter of that) not an "organic whole" in which parts are related in an intrinsic manner so that each part derives its meaning and significance in relation to the whole; if so, any isolated comparison of the part is by definition misleading and contrary to canons of logic in general and of Gestalt psychology in particular?
2. In a system, should not the comparison or application be made in terms of its *essence*, rather than of property or accident (if the last-named is inseparable)? This means the author instituting a comparison or suggesting application should in the first instance present the *essentials* of the system(s), i.e. separate the wheat from the chaff. The definition, I need hardly repeat, is given *per genus et differentium.* If the differantium is not taken into account, that application of a particular school may well pass off as the application of other, and even of its rival system.
3. Should not a distinction be maintained between application of which the authors of a system are conscious, and application which an outsider reads into the system? Only the first is strictly speaking an application; the second misfittingly be designated as interpretation?

In raising the above questions, my intentions have been to focus attention on methodological issues of such studies. I shall not attempt the answer, for I would like the answers to be discussed here.

2. UDAI PAREEK (Delhi) : *Comparing achievevment of basic and non-basic Children.*

1. The problem of comparing achievement of Basic and non-Basic school children is an important, though an intricate one.

2. The comparative study of both types of syllabii is important in this connection.

3. Equally important is the question of studying achievement of the pupils at the secondary school level.

4. Of the studies so far undertaken in this direction four are worth mentioning : those of Kamat, Chatterjee, Jape and Mohsin. The results of these studies have been mentioned.

5. Some points have been raised in connection with the problem of comparative study of achievement. In view of the different objectives of these two types of education, the justification of comparative studies by once single evaluating instrument is questionable.

6. Equally questionable is the use of the same tests for both types of children who are taught in different ways and by different methodologies. A suggestion has been made to undertake studies which can throw light on the effect of the form of test on achievement.

7. The most difficult problem in this connection is that of equating groups. Groups have to be equated on various factors which include age, intelligence, socio-economic status, teaching, school conditions, teacher-pupil relationship and distribution of time-table. The usefulness of such studies is doubtful.

3. RAJNARAYAN : *Multipurpose Schools.*

Conditions for founding of multi-purpose schools :

1. Compulsory universal education beyond primary stage of education;
2. Educational and humanitarian aspect of failures ;
3. Discovery of individual differences in aptitudes.

These three conditions have given rise to the founding of multi-purpose schools. Where such schools have come into being, the psychological problems facing them are in regard to (i) the difficulty of determining the nature and number of primary mental abilities, and (ii) deciding as to whether aptitudes in the 'psychological (unitary traits) or 'Vocational' sense should form the basis of the several streams of multi-purpose schools.

The problems are still not yet with us, because education in our country has not progressed beyond the primary stage (and that too in the cities) in being compulsory.

4. E. W. MENZEL : *Basic Education.*

Basic Education is on the whole based on sound pedagogical principles and is designed to meet real needs. Particularly admirable are its programs for the teaching of health, and social activities and its emphasis on craft and community improvement. Health and citizenship can be taught in no other way than through doing . . . and this is provided for in Basic Education.

It must however not be permitted to be regarded as a political programme. All parts of it must be appraised and criticized and modified in the light of experience and in the light of its development in actual practice. At present there are many types of basic schools some of which are good, indifferent, or merely nominal. The following criticisms are offered :

1. The teaching of craft is very essential both for its immediately practical values and for the psychological effect. But concentration on a single craft in the primary stage is inadvisable. This is too early a stage for specialization. Small children benefit from being engaged in a variety of practical activities.
2. The economic implications of crafts depend not only on the school programme but economic development in the country as a whole. Seemingly khadi is not going to be the source of supply for textiles that was expected. Professional weavers find it very difficult to make a living. If this is true spinning and weaving do not offer the economic opportunities originally planned. Khadi was at one time very significant as a political issue but the question of the usefulness and possibility of basic crafts of real

economic importance needs to be re-examined in the light of economic reality. It should be the purpose of the school to make children practical, alive to the economic needs of the family, community, and nation, and prepared to be self-sufficient as well as cooperative to the utmost extent possible. But this cannot be achieved by claiming to teach livelihoods which contain little possibility of becoming real livelihoods or even supplements to a livelihood.

3. The tool subjects (reading and writing and arithmetical) must not be neglected. In many schools the enthusiasm for social and craft activities has led to the neglect of the traditional literary skills which continue to be indispensible for further education. The traditional subjects usurped almost the full time in the old type schools but were taught very poorly. They need to be taught better than before but in far less time. They can be taught twice as well as formerly in half the time if better educational psychology is employed leaving ample time for the novel elements in Basic Education. Efficiency must be striven for from both sides so that there will not be a complete divorce between Basic Ed. on the one hand and literary and scientific or technical education on the other hand.

CULTURE AND PERSONALITY

(Jointly with the Section of Anthropology & Archaeology)

Chairman: PROF. S. M. MOHSIN.

The paper will begin with a brief historical survey of the field of Culture and Personality. It will then go on to outline some of the major works in culture and personality and the manner in which the discipline is developing in the West. Curiously, there is a seeming contradiction. The field of Culture and Personality, which has been created by an attempt to combine the insights from Psychology and Psychoanalysis into researches in Anthropology and Sociology, started with British anthropologists like Rivers and Malinowski. But in its major developments today, American anthropologists have the monopoly. British anthropologists have simply sat back and restricted themselves to the traditional ways in anthropology. The paper will conclude with an outline of some of the unsolved problems in this field and with some suggestions as to the possible future course to be pursued in solving them.

2. PROF. S. C. MITRA (Calcutta): *Standards of Culture and Personality Norms.*

In discussing culture contacts and culture conflicts, anthropologists often use the terms 'higher' and 'lower' cultures. The undersigned pointed out that the terms 'higher' and 'lower' always have some reference to a standard, but as there can be no universal standard, no specific meanings can be attached to the terms 'higher culture' and 'lower culture'. The meanings that are sought to be attached to them are but rationalisations. On some grounds or other we often arbitrarily select a particular item or a social phenomenon and take that for our standard. That is however not justifiable.

Similarly there is no universal frame of reference for judging personalities. A person who is judged to be abnormal in one society may not be so judged in another society. Norms both in the ethical and in the statistical sense have relative values only.

The principle of relativity should be accepted in psychology as also in cultural anthropology.

3. NIRMAL K. BOSE (Calcutta) : *Personality and Culture Change.*

Every culture looks upon certain types of personality as desirable or good. and others as undesirable. The situation becomes critical when cultures which stand sharply in contrast with one another come into mutual contact.

It has been observed that under such a situation, the traits which form part of the culture which is economically and/or politically dominant tend to spread among members of the other culture. Traits associated with the subservient culture tend to lose the respect which they formerly commanded.

When we analyse the characteristics of the personality of the second group, various interesting features are observed. In the economically/politically subservient group, there may be some who feel renewed pride in the values associated with the old culture. This defensive attitude leads to an over valuation of some traits, when the disturbing facts which run counter to the latter are undervalued or forgotten. Other social groups similarly may be led in their enthusiasm to overvalue some parts of the immigrant culture and an undervaluation of disturbing elements.

Just as society may thus be divided into classes who thrive on 'myths' created out of the past or out of the present, so also within the same person, we may come across a parallel conflict of loyalties and of emotions. The same person in one social setting may display a highly individualistic, unsocial and destructive attitude, while in another, may be apt to surrender his individual opinions gladly 'in a noble cause'.

It is suggested that the presence of such internal psychological tensions, i.e. unresolved conflicts, leads to a situation when the individuals are unable to use their mental powers in a creative manner. Before that can be done, and a proper use made of the talents of everyone concerned, it is necessary that the internal conflicts should be resolved in one way or another.

4. K. P. CHATTOPADHYAY : *Personality and Culture.*

Personality may be defined as a more or less integrated system of tendencies to respond to the environment in the field of purposive behaviour. The quality of response will depend on the innate equipment of a person but the direction which responses will follow will be determined by significant repetitive behaviour. Attention is drawn to stimuli which satisfies or obstructs fulfilment of some need of the observer. The need may be biological, based on physiological functions and it may also be a cultural need. The two however interpenetrate. Examples were given from (a) a hungry child from a poor family at first accidentally and then deliberately receiving food by taking it when it was not his and (b) a daughter-in-law in a tribal area compelled to steal food when kept short by the mother-in-law. How this feeling of need is relative was also illustrated from Cyril Burt's work on London children who had become delinquent from refugee children.

The importance of the sub-culture in which a man grows was stressed by examples of personality traits from the life of Mahatma Gandhi and of Raja Rammohan Ray. Two other examples were given from the lives of two tribal headmen in Mayurbhanj. It was indicated how the early cultural environment had moulded personality; but there were sharp differences between the two men based on different family environment. The psychophysical structure with which a man is born plus the subculture in which he spends his early life and youth determine personality traits.

5. W. T. V. ADISESHIAH (New Delhi) : *Personality and Culture.*

1. *Introduction.*—During the past few decades, the national leaders of India have been emphasizing the need for cultural development in a social setting which

is rapidly undergoing sweeping technical changes. Oral traditions are being replaced by the written word. This is bringing into existence a steadily growing class of neo-literates. Culture contacts, meetings and exchanges of views calculated to foster mutual understanding between peoples of different cultural traditions has brought individuals into closer relationships with each other.

2. *Community Development.*—A higher cultural level among the populations of cities and villages is a factor in social progress. In communities where such facilities as museums, libraries and well organized media of mass communication are available, individuals have developed cooperativeness, self-reliance and greater initiative. There has been a marked growth in civic sense.

3. *Technical Changes.*—Repetitiveness, mechanical pacing, low skill requirements and predetermination of tools and techniques are some of the distinctive features of modern technical changes. These act as obstacles to social satisfaction and decrease opportunities for self expression. Participation in technical change, gaining an understanding of the purpose of the change and application of the techniques of preservation and restoration of cultural values have had the effect of making individuals conscious of their cultural integrity and more efficient in the fulfilment of their social roles.

4. *Neo Literates.*—In many parts of the world, social and cultural development of communities is retarded by the paucity of reading material, which will carry the newly literate persons from bare literacy to a stage at which they can read with ease. Organised efforts are now afoot to produce well planned, interesting reading material, with attractive illustrations. This has arrested the relapse of many persons into illiteracy, when they are plunged in surroundings which offer them no scope for developing the habit of reading.

5. *Mass Communication.*—Recent years have witnessed many improvements in training facilities in all the information media, especially in the field of film and television. Action for the free flow of information, reduction of obstacles to the transmission of news, international circulation of educational, scientific and cultural materials and the movement of persons have contributed to significant advances in the techniques of mass communication. As a result of these a very much larger circle of people in every country has come under the influence of organised cultural transmission than was possible in the past.

6. *International Cultural Exchange.*—Study abroad is one of the most effective ways through which an increasing number of persons throughout the world are being given a direct personal experience of how people in other countries work and live. Individual participation in study tours, training courses, conferences etc., have helped many to make value contacts with trade unions, cooperatives and popular cultural associations. The technique of group study tours has been found to be highly useful.

6. DR. FRANCIS L. K. HSU.

The basic problem of Culture and Personality is like that of all sciences, viz., to analyse the phenomena under scrutiny so as to be able to understand them, and eventually to predict and to control them. In the case of the study of culture and personality the phenomenon under scrutiny consists of human behaviour and the problem before us today is how best we can achieve the scientific object described above as it pertains to human behaviour.

Anthropologists came to blind alley some 30 years ago. They exhausted the utility of such concepts as diffusion, evolution etc., and were faced with massive amounts of descriptive data with order sometimes, but without destination. The psycho-analysis of Freud came to the rescue and helped the anthropologists to obtain a new dimension in their treatment of cultural data. It had certainly helped the anthropologists to release much new creative energy, Unfortunately some anthropologists went too far. We have a number of works by anthropologists and sometimes by psycho-analysts which can only be described as psycho-analyses of whole societies. At the worst they are even like magic thinking viz., by arguments of analogy and even by free association.

Fortunately the pendulum does not always swing in one direction and we have some splendid works by scholars like Kluckholm and Mowrer who tried to provide a more adequate basis for generalization so that while the anthropologists can make use of the insights from the psychological sciences, they will also not lose sight of the fact that their generalizations must be applicable to the majority of the normally functioning individuals in any given society.

In my view however the most important thing that the students of culture and personality should see is the overwhelming importance of the cultural factor in the behaviour of the normally functioning individual in his group. In this it is necessary to realize that the normally functioning man is not an individual individuals. He can only carry on his life in association with a group or groups. Dr. Mitra spoke of the confusion that the anthropologists caused the psychologists in connection with the former's many definitions of culture. There is however no real point for confusion. Culture is simply the pattern of conduct of a given society accepted by the majority of that society. I am interested to note that Dr. Mitra did not mention the confusion that the psychologists have presented to anthropologists in the matter of the numerous definitions of the term personality. If we look at an old book by Dr. Gordon Allport on the subject we shall find that there are no less than fifty definitions of the term. But I think we have not been confused; we have refused to be confused inspite of the diversity of the definition. Personality is simply the characteristic ways of the individual's behaviour and their motivation.

If we take these relatively simple distinctions of culture and of personality and avoid splitting of hair and mincing words, we shall not find it difficulty to proceed. One of the important ways in proceeding in the study of culture and personality is to have a clear conception as to what is normal and what is abnormal. We have seen many learned discussions on the subject of normality and abnormality as if there is no question about their definition, and that the goal of psychiatrists and clinicians is to restore the abnormal to the normal. But equally often we have been told that normally and abnormally is divided not by any clear line. In fact the line cannot be drawn. It seems to me that it will be impossible if we concurrently accept both of these positions and remain in ambiguity in our thinking. There are of course individuals who are far gone in mental abnormality. These are individuals who, either for organic or functional reasons, are unable to relate themselves to any group. This will be truly the abnormal person. On the other hand for the majority of us who are functioning as members of a given society, the term normal must be applied. This is not to say that most of us will not have some germs or symptoms similar with those found in the truly abnormal as defined above. The point is that we are able to compensate the difficulties created by these germs and symptoms by the possession of qualities in our personality which enable us to function as members of our given societies inspite of them. If we examine a majority of the working population in any given city today we will find that most of them will contain germs and symptoms of some physical illness which are identical with those to be found in patients lying in hospitals. But a majority of the working population in any modern city today are not classified as physically sick, for the simple reason that germs and symptoms have not incapacitated them in carrying out their normal activities in any significant way. It will serve no useful purpose if we declare that the majority of the working population is sick, in precisely same way it will be folly of follies if we classify the majority of the members of any society as being abnormal.

7. UDAY SHANKER, Delhi-8.

The individual is never separate from the environment and human life truly human is only possible in a social group. In the social group there are not only relationships with other human beings in the super-individual units which affect him, but one's personality is affected and moulded by the social forces, cultural contents and modes of thought, feelings and patterns of behaviour. In fact each personality reflects the social milieu in which it has been fashioned. Since social values and cultural patterns change and since personality is a product of these dynamic and changing influences, there is no absoluteness about personality which is a relative concept and there is no fixity of traits which differ from person to person and which change from generation to generation, group to group and age to age. Anthropological evidence has amply brought it out and in the modern world also we see the different attitudes and approaches to life in the different social groups which not only colour their behaviour patterns but condition their adjustment and mental health. The philosophy of renunciation and of an objective and detached attitude in the Indian masses on the whole, which saved many from breakdown and neurosis at the time of partition, can be quoted an evidence to prove the contention, in contast with the American psychology of action making one more nervous, strung and sensitive with a facile tendency to psychism or neurosis. But due to cultural influences of the West and due to modern education and other thought forms we, in this country, also find a dichotomy in society producing two groups of the people; one more educated and sophisticated urban type and the other more illiterate, native, indigenous rural type, both feeling extreme distance towards each other and a great strain in mutual adjustment leading to suspicion, distrust, hostility and incompatibility among them and producing so much mental ill-health. If we in this country wish to have a healthy society, the cultural barriers and differences in the 2 emerging groups have to be broken or toned down by whatever means.

8. NIROD MUKERJI (Gauhati) : *A Plea for New Referents.*

The theme of this paper may be summed up as in the following :—Culture and personality are comparative concepts; one concerns mainly the group, and the other individual participants of the group. It is therefore natural to seek for a suitable frame of reference. The constituents of such a framework have here been termed as *referents*. In the portraiture of ethnical relationship anthropologists have mainly used referents used in psychology which have evolved in a particular context. In bringing their referents to popular usage psychologists have, more often than not, used as their subjects members of such communities which have been very much influenced by modern industrial development. It is debatable whether such referents could be freely used to delineate the psychical states of other communities which have had no concern with the mode of living bearing contact with industrial civilization. It is, therefore, suggested that efforts were made to devise new sets of referents which could be used for studying ethnical groups in general overcoming the drawbacks of the older ones.

9. P. C. RAY (Calcutta) :

You have so long listened to the Psychologists and Anthropologists, differing considerably with regard to their views on culture and personality. I think that there should not be any serious difference. As a matter of fact, the difference lies in the shift of emphasis.

You know that the psychological organism is not a person but an individual. When the individual becomes the agent of society, he is called a person, and the personality is nothing but attribute of persons. The cultural anthropologist sees the human being from the cultural standpoint, and so, he is dealing with the basic personality structure, i.e., the common elements exhibited by persons, by which an Indian may be differentiated from, say an European, whereas the psychologists mainly deal with the uniqueness of a person, by which an Indian may be differentiated from another Indian.

In short, it may be said that the difference between the two schools will disappear, if it is remembered that any cultural manifestation require a determinate human being, and as such, culture cannot be conceived without its carrier.

10. NIRMAL KUMAR BOSE : *Culture and Personality.*

Dr. S. C. Mitra has posed a number of questions to anthropologists. It is in relation to those questions that the present note is submitted.

All parts of human behaviour do not form the subject matter of anthropology. It is only that portion of behaviour which is standardized, and then passed on from one group to another (separated from it by space or time) which concerns the another.

Progress, as understood by anthropologists, is again perhaps no more than continuous change. Whether we can a process of change progressive or not, depends upon what we choose as the criteria of progress. A subjective element thus enters into it.

While culture changes, the loyalty of people to culture items also changes. Some bestow loyalty upon an imaginary past or an imaginary future; and both can be looked upon as an escape from the responsibilities of the present. In a culturally disturbed situation such loyalties show wide variability, more or less comparable to the deflection of a compass in a magnetic storm.

11. W. T. V. ADISESHIAH (New Delhi) :

1. *Introduction.* During the past few decades, the national leaders of India have been emphasizing the need for cultural development in a social setting which is rapidly undergoing sweeping technical changes. Oral traditions are being replaced by the written words. This is bringing into existence a steadily growing class of neo-literates. Cultural contacts, meetings and exchanges of views calculated to foster mutual understanding between peoples of different cultural traditions have brought individuals into closer relationships with each other.

2. *Community Development.* A higher cultural level among the populations of cities and villages is a factor in social progress. In communities where such facilities as museums, libraries and well organized media of mass communication are available, individuals have developed co-operativeness, self-reliance and greater initiative. There has been a marked growth in civic sense.

3. *Technical Changes.* Repetitiveness, mechanical pacing, low skill requirements and predetermination of tools and techniques are some of the distinctive features of modern technical changes. These act as obstacles to social satisfaction and decrease opportunities for self-expression. Participation in technical change, gaining an understanding of the purpose of the change and application of the techniques of preservation and restoration of cultural values have had the effect of making individuals, conscious of their cultural integrity and more efficient in the fulfilment of their social roles.

4. *Neo Literates.* In many parts of the world, social and cultural development of communities is retarded by the paucity of reading material, which will carry the newly literate persons from bare literacy to a stage at which they can read with ease. Organised efforts are now afoot to produce well planned, interesting reading material, with attractive illustrations. This has arrested the relapse of many persons into illiteracy, when they are plunged in surroundings which offer them no scope for developing the habit of reading.

5. *Mass Communication.* Recent years have witnessed many improvements in training facilities in all the formation media, especially in the field of film and television. Action for the free flow of information, reduction of obstacles to the transmission of news, international circulation of educational, scientific and cultural materials and the movement of persons have contributed to significant advances in the techniques of mass communication. As a result of these a very much larger circle of people in every country has come under the influence of organised cultural transmission than was possible in the past.

6. *International Cultural Exchange.* Study abroad is one of the most effective ways through which an increasing number of persons throughout the world are being given a direct personal experience of how people in other countries work and live. Individual participation in study tours, training courses, conferences etc., have helped many to make valuable contacts with trade unions, co-operatives and popular cultural associations. The technique of group study tours has been found to be highly useful.

I. SOME PROBLEMS IN RESEARCH IN ENGINEERING AND TECHNOLOGY

Section of Engineering and Metallurgy

Chairman : DR. G. P. CHATTERJEE, Howrah.

1. DR. G. P. CHATTERJEE (Howrah) :

The subject of the symposium covers quite a wide area in the field of Engineering and Technology and in fact several symposia are necessary to do full justice to the problem. In the field of metallurgy alone the problems of research—fundamental and applied are many and so it must be with each branch of engineering. Development of new alloys with particular reference to indigenous materials, production of essential key metals from poor grade ores or metal bearing products, the low shaft furnace for production of iron and ferro-alloys, the Oxygen method of production of steel, production of Titanium, Zirconium, Thorium, Uranium and other metals for atomic power development and part of other problems are before us which have great future potentialities for this country. We have here a few papers from the Atomic Energy Establishment (Bombay), a paper from the Ordnance Factory, Ishapore and also from the Technical Development Establishment, Bangalore. I am sure that the discussions (though somewhat limited in scope) will be of interest to you. It is my earnest suggestion that discussions on problems in Research in different fields of Engineering and Technology should continue as a permanent features of the Engineering and Metallurgy Section of the Congress in future years.

2. PROF. B. D. NAG CHOUDHURY (Calcutta) :

Atomic Energy development is more an engineering and metallurgical problem than of pure Physics or Chemistry. True it is that Engineers have taken advantage of the fundamental contributions made by the Physicists. Vacuum testing by the Mass Spectrometer, temperature stable radicals by the Mass Spectrometer and host of other instances are typical examples. But Engineering and Technology are on the "giving" or "credit" side of the problem of atomic power plant development. The question of Chemical separation of isotopes was solved not by the conventional chemical methods but by Chemical engineering methods in a Chemical Engineering Plant by Automatic Valves and remote control methods. I am very glad that the Engineering and Metallurgy Section of the Congress has taken up some of the problems on Nuclear power development as a part of the symposium.

3. DR. M. R. SRINIVASAN (Bombay) : *Reactor types and their applications of Power Generation.*

A brief description is given of nuclear reactors and their potential for power generation. The different types of reactors are classified according to the type of moderator and coolant used. The advantages and limitations with these several types are briefly discussed. The early systems which must be natural uranium systems are discussed in greater detail.

The engineering problems involved in using the graphite and heavy water systems for power generation are considered. The pressure shell and the pressure tube constructions are looked into and the implications of the type of construction on neutron economy and construction cost of the reactor are studied. The types of thermodynamic cycles that must be used with the two types of reactors are described. The economics of externally fired superheaters in the case of the water systems and the use of multipressure cycles are discussed.

The method of costing power from nuclear reactors is demonstrated. The estimation of the cost of refuelling is illustrated. The economics of heavy water and graphite natural uranium systems are compared. The future trend in the economics of nuclear power through the uses of enriched fuel and breeding systems is indicated in a general way.

4. G. SRIKANTIAH (Bombay) : *Some heat transfer aspects of Nuclear Reactors.*

Reactors may be classified on the type of cooling adopted such as, boiling water reactor, liquid-metal and gas cooled reactors, circulating fuel reactor, etc. The heat transfer aspects which determine the fuel element design in such reactors are presented in this paper. The thermal and nuclear properties which are required from a reactor coolant are described. A comparison of pumping power requirements of different gas and liquid coolants has been made based on thermal property groups, which brings out the advantages of hydrogen and carbon dioxide over other gas coolants.

From an analysis of heat transfer and flow characteristics in water moderated and cooled reactors, it is found that the boiling water reactor has decided advantages over other types. A discussion of pumping power requirements of liquid metals shows the superiority of sodium, though special pumps are required. Finally a brief description is given of the homogeneous and liquid metal fuel reactors.

5. S. K. KANTAN (Bombay) : *Some experiments in reduction of Uranium components to Uranium metal.*

Experiments have been conducted to make uranium in the form of powder. Uranium powder is produced by the electrolytic reduction of KUF_5, UF_4 and UCl_4 and also by chemical reduction of the oxides. In the case of electrolytic reduction various factors such as current density, temperature of the bath and concentration with respect to uranium etc. have been studied. Chemical reduction of the oxides UO_2, U_3O_8 with calcium and calcium hydride has been investigated and the effect of the excess of the reductant, temperature and time of reduction have been studied.

6. J. A. TARAPOREVALA (Bombay) : *Planning of Laboratories.*

In connection with the Atomic Energy Project, a number of laboratories have to be built at a site in Trombay which is situated about 20 miles to the north of Bombay. A study was made in connection with orientation, air-conditioning, various sizes of rooms and corridors and problems in connection with services, furniture, lighting, building construction etc. This paper deals with two of these problems in their planning stage viz., orientation and air-conditioning.

2. Orientation was studied from the movement of the sun in three seasons—summer, winter and fall or spring. Figures 2, 3 and 4 give these positions. From these diagrams it is possible for any orientation of the building to determine shadows produced by horizontal and vertical projections on the walls. For a wall facing east-west, it is found that the best solution is to have vertical sun-breakers as in figure 8. In northern places like Delhi and Chandigarh where winter is severe for about 3 months and where heating has to be resorted to, the best solution is to have vertical sun-breakers which are capable of rotation which could be brought about by either manual or mechanical means. Subsequently, on a study of air-conditioning, it was found that these sun-breakers are an economic proposition, because they prevent the maximum sun load getting inside the building thus materially reducing the size of the cooling plant. This is exactly the reason why one of the latest structures in Bombay presents no view of windows at all from outside because of these vertical sun-breakers.

3. Economics of air-conditioning was then considered both for the laboratory and for residential purposes. As a result of this study, the following rules were evolved :—

(*a*) Windows must be fixed to prevent infiltration.

(*b*) Double glazed windows with an air gap should be used to reduce heat transmission.

(*c*) Hollow or insulated walls must be used.

(*d*) In the roof, a layer of insulating material should always be used.

(*e*) No wall of a building should be exposed to the sun by providing vertical sun-breakers or horizontal projections.

(*f*) Where heating and air-conditioning have both to be resorted to in different seasons, rotating sun-breakers should be installed.

(*g*) As far as possible, the terrace should not be exposed to the sun. It should be covered by a roof, the covered area being used as storage space.

(*h*) If terrace is exposed to the sun, it should be paved with shining China mosaic on brickbat koba as water-proofer in preference to any dark coloured bitumastic or rubber composition in order that less heat may be absorbed by the terrace.

(*i*) All furnaces in air-conditioned rooms should be placed in outside walls like window air-conditioners so that little heat is allowed to enter the rooms.

(*j*) For residential purposes for the upper income group, economics should always be worked out whether it would not be cheaper to put up small air-conditioned houses instead of spacious ones. Air-conditioned apartments of low ceiling with built-in wall cup-boards and of a size a little bigger than steamer cabins could be quite comfortable and cheaper to live in, particularly with high wages of servants.

4. The final result of this study of the economics of insulation and protecting the terrace by a covered roof or spraying it with water and the use of fixed double glazed windows are all given in tables I to V. It is worth noting that it is possible to purchase a standby plant to prevent failure and yet save a lot of money by making the windows fixed thus preventing infiltration of outside air at about 15° higher temperature getting inside the building.

5. It will be seen that great economy is possible by intelligent use of insulation and preventing the sun by all means playing on either the walls, windows or the roof. One axiom is very strongly brought out with regard to air-conditioning and that is "keep the sun off" and it is shown that it is uneconomic to let the sun in first and then to use a costly cooling plant to get rid of this heat.

7. LT. COL. B. M. CHAKRAVARTY (Bangalore) : *Military Electronics.*

Under the Controller General of Defence Production of the Defence Production Board, in the Ministry of Defence, there is a chain of research, development and inspection establishments in our country. These laboratories interpret the Forces' requirements of equipment and stores in technical specifications and are carrying out constant high grade technical work to keep our Defence Forces provided with the latest in armaments and accessories. These TDEs are responsible for ensuring that our Defence Forces become independent of foreign imports in their requirements of armaments and other equipment.

8. N. R. KRISHNASWAMY (Ishapore) : *Some modern developments in iron making processes and their applicability to the use of magnetite ores of Salem and Trichinopoly Districts of Madras.*

Swedish Iron and Steel Works use the lean magnetite ore for manufacture of iron suitable for making high quality steels for which Sweden is world famous. Magnetite ores of Salem and Trichinopoly districts of the Madras State are similar to the lean ores of Central Sweden. The fuel and hydro-electric power position in the Madras State being similar to that of Central Sweden, modern development in iron making process in Sweden may be applicable to Madras State.

The most modern development on the iron making process in Sweden is the sponge iron manufacture by Wiberg Soderfors process which has been established as a regular production unit since 1953. The essential raw materials required for this process are : (1) highly oxidised, easily reducible pellets made from finely ground and highly concentrated magnetite ores with low phosphorus content, (2) any coke which has low volatile matter and (3) electrical energy to heat the coke in the carburettor.

Pelletising process in Sweden consists of (a) making green pellets of wet finely ground magnetite concentrates in a rotating cylinder which is kept slightly inclined to the horizontal and (b) burning of green pellets in a shaft furnace to get the highly oxidised, easily reducible but strong pellets.

LURGI Pelletising process developed in West Germany in their experimental station at Watenstedt is described. The method of manufacture of green pellets from the wet magnetite concentrates would be by using an inclined rotating bowl (segment of a sphere) and burning these green pellets on a sinter belt which appears to be much easier to control than the burning of green pellets in shaft furnace as is practised in Sweden. The capital cost of the plant and the fuel consumption in LURGI Pelletising process may be higher than the present Swedish practice.

Since the Demag-Humboldt Low-shaft blast furnace process is being considered for iron making in Madras State, a description of the (a) Pilot plant, (b) material balance and (c) the composition of the pig iron produced are given.

The advantage of sponge iron as raw material for high quality steel manufacture and the relative cheapness of the acid steel melting process when compared with the basic steel melting process are brought out. The pig iron produced by low shaft blast furnace being higher in P content [(a) due to the higher P content in the magnetite concentrate with low Fe content and (b) P content from the ash of the fuel getting into the pig iron] can be used in basic steel melting process only and hence it cannot compete with sponge iron for manufacture of high quality steel.

9. U. K. SEN (Kharagpur) : *Some aspects of Mathematical and Statistical methods.*

In many research problems of Engineering and Technology mathematical and statistical methods of recent development are being applied a brief survey of some of the *following* methods with particular emphasis on the situations calling for their applicability were discussed :—

1. Linear programming (Mathematical method).
2. Correlation Analysis (Statistical method).
3. Exploration of response surface (Statistical method).

In this paper a brief survey has been made of a few of the mathematical and statistical method of recent development viz. linear programming, correlation analysis and exploration of response surface, which are being applied to many research problems of Engineering and Technology. The mathematical formulation has been made and emphasis has been laid on the situations calling for their applicability. Reference has also been made to the fields of their applications which include structural design, prediction scheduling, blending of gasoline, prediction problems in communication engineering, practical problems of seismology, decision making in a production programme, determination of the best operating conditions in a chemical process and others.

II. DEVELOPMENT OF POWER AND WATER RESOURCES OF WEST BENGAL

Chairman : Dr. G. P. Chatterjee (Howrah).

1. Dr. G. P. CHATTERJEE (Howrah) : *Introductory remarks.*

Rivers may be helpful for irrigation, navigation and as sources of power. This has been amply demonstrated from the work so far done in other countries. Nevertheless there is considerable scope for work for the scientist as well as the engineer not only for controlling floods but diverting the heavy volume of water with its useful mineral contents for irrigation purposes and also wherever possible for the generation of electrical energy. The problem is by no means easy. There is the problem of collecting comprehensive hydrological data, the soil erosion problem, the silt problem, the different geological aspects of the problem, the forestry in relation to the problem of soil conservation and last but not the least the financial problem. But I have no hesitation to feel that the solution of all these problems lies on the resolute will of the people, the scientist and the engineer. There is no doubt that the learned discussions this afternoon from scientists and engineers in different allied fields of discipline will bring into light different aspects of the problem. We feel particularly glad that Dr. B. C. Roy, Chief Minister of the State of West Bengal and an eminent Scientist is with us to inaugurate the symposium in spite of his other multifarious duties. We are also fortunate to have Sri Ajoy Mukherjee, Minister for Irrigation and Waterways, Government of West Bengal to guide us in the deliberations.

2. Dr. B. C. ROY (Calcutta) :

Irrigation and cheap power are the two main factors for the building up of a good economy. So far as West Bengal is concerned there are problems which required to be carefully looked into. Many West Bengal rivers have become silted up as a result of which large tracts of land have become waterlogged or have dried up. The problem of the Sunderbans is another major issue.

Rivers which fell into sea including the Hooghly used to be fed by water from upland areas. Gradually with the moving of the course of the river Ganga between Murshidabad and Malda the flow is now cut off except for two or three months during rainy season. Communication between different parts of India through Ganga have also been cut off. With the cutting up of upland water, beds of the Sundarbans rivers are gradually rising and the bunds which were satisfactory in the past have now become less and less efficient for the purpose for which those are meant. The cost of embankments become higher as the river beds also become higher and higher. This has resulted in a vicious circle. West Bengal has several instances where storm and cyclone resulted in the innundation of large areas. It is up to engineers to find out how to bring about engineering arrangements so that upland water might again flow in the deltaic rivers.

Cheap power is necessary for the development of cottage industry. Our country is not rich and we want to be rich. By utilising their knowledge and intellect and helping us to have cheap power and better irrigation the engineers can help us in implementing our objectives in the Second Five-year Plan.

3. SRI AJOY MUKHERJEE (Calcutta) :

West Bengal power and water resources are plentiful and varied. In the north, in the sub-mountainous tracts of the Himalayas they have such mighty hill streams as the Teesta, Jaldhaka, Torsa, Rydak and Sankosh. They are vast potential sources of hydel energy and irrigation water supply. In this tract they are short of coal or oil and the whole region has to depend for its energy supply on timber fuel that is obtained by felling trees in the forests of the Terrai and the Dooars and also in the hilly uplands. This indiscriminate destruction of soil cover and felling of trees surreptitiously by the local people has created such a widespread denudation of the forest areas during the last world war that they have witnessed during the last few years widespread destruction of land and crops by extensive floodings. It is hoped that the problem would be successfully tackled by the engineers and scientists who are now devoting their attention to this region.

One of the potential sources of energy in West Bengal in the deltaic region is the tide. This source of energy has as yet to be successfully tackled. In the estuaries of Hooghly, Thankuran and Rai Mangal in the Sundarbans, the range and strength of the tides are enormous and if properly harnessed may yield energies that are badly needed in this area. The development and distribution of cheap power is essential to a country where drainage congestion is chronic. The last September flooding have underlined this aspect of our problem very prominently. We may succeed partially in removing this congestion by cleaning and proper alignments of the channél, but the outfalls of these channels being tidal, we may have to resort to intensive pumping which has been found so successful in low countries like the Netherlands.

4. DR. U. K. BOSE (New Delhi) : *Preliminary Meteorological Study Associated with West Bengal Rivers.*

Meteorological studies confined within the geographical limits of the State may be expected to yield results for flood studies, only of secondary significance.

As a preliminary study in this direction, district rainfalls of all the districts in West Bengal for certain selected seven-day periods during south-west monsoon season were examined. 48 such selected periods were used to prepare a very rough average-depth-area-diagram. No attempt was naturally made to draw an enveloping depth-area-duration curve, as practised by several workers (U.S.A. Weather Bureau Cooperative Studies Technical Paper 1946). Nevertheless the average highest rainfall and the area of the districts in which this rainfall occurred do give, in a qualitative way, an idea of the extent and amount of rainfall during the selected periods. A histogram showing the frequencies of storms with different area of maximum rainfall divided into classes of 1000 sq miles size was also prepared. The average maximum rainfall of all storms falling within the class 2000-3000 sq miles were taken to find the average maximum rainfall of a hypothetical mean storm. Similarly a hypothetical mean storm was found for the class with area 3000-4000 sq miles. The rainwater involved in the above two hypothetical mean storms were expressed in run-off units. The run-off figures thus obtained were found to be of the same order of magnitude as the average run-off during the monsoon season in any one of the main rivers entering West Bengal and bringing its water into areas within the State of West Bengal.

Two of the periods selected were further examined by drawing stormisohyetal maps using all available rainfall data for raingauge stations in West Bengal and contiguous parts of Bihar and discussed.

The periods selected for this study divide into two classes (1) those cases in which maximum precipitation area is located in Sub-Himalayan West Bengal (28), (2) cases in which maximum precipitation area is located in Gangetic West Bengal (20). A large number of selected periods of type (1) coincide with periods of high floods in West Bengal rivers as reported from hydrological observations. Further detailed study of rainfall pattern in the Sub-Himalayan West Bengal therefore appear fruitful. Necessity of rainfall data extending over a reasonably long period from a more dense network of raingauges extending to Sikkim as well as setting up of a number of S.R. raingauges urgently is indicated so that during the course of next 4/5 years some amount of data of intensity of rainfall becomes available on the basis of which any rigorous quantitative investigation of rainfall, surface run-off etc. could be commenced.

5. SRI K. C. CHAKRAVORTTY (Alipore) : *Principal Meteorological Conditions in Relation to the Floods of West Bengal Rivers.*

Floods occur at times in some villages of West Bengal and cause considerable damage. In modern times people have learnt not to yield helplessly to these destructive phenomena as God-sent catastrophes but to fight them in a scientific way to their advantages. The designing and execution of the flood control works have, therefore, been receiving serious considerations of the Government and the public in recent years. In this connection besides other subjects a critical study of the meteorological conditions favourable for the production of intense rainfall resulting in the flooding of the rivers concerned is essential. An examination of the past data reveals that the floods in West Bengal rivers occur only in the monsoon months (particularly during July to September) but the synoptic situations responsible for the production of intense rain resulting in such floods are different for the rivers in the North and the South. Intense rain at the sources and catchments of the rivers in Sub-Himalayan West Bengal is almost always associated with "break" conditions in the monsoon (i.e. when the axis of the monsoon trough shifts to the foot of the Himalayas) particularly when such a "break" condition occurs simultaneously with the movement of Western disturbances across the Eastern Himalayas. The intense rain responsible for the floods in the rivers in the South originating from the Chotanagpur Hills takes place with the full prevalence of Southwest monsoon over Gangetic West Bengal and Chotanagpur in association with the north-westward movement of depressions and storms of Bay origin across Orissa-Bengal coast or of land depressions from the east particularly when the movements of these depressions and storms are exceptionally slow.

With due consideration to the points mentioned above heavy rain is predicted by India Meteorological Department for the source and catchments of West Bengal rivers and heavy rainfall warnings are issued 24 to 36 hours ahead. Warnings against flood are, however, not envisaged in these forecasts. In order to estimate the precipitation quantitatively with reference to time and space in connection with any disturbance an elaborate process of analysis on the basis of data from an appropriate network of observatories is necessary. From a study of the distribution of precipitation with reference to the previous life history of a disturbance and its existing conditions it may be possible to prepare prognostic depth-area curves at suitable intervals and estimate the precipitation quantitatively over the area to be affected by the disturbances.

6. SRI A. DAS (Alipore) : *The Problems of West Bengal Rivers with particular reference to rainfall in their catchments during Southwest Monsoon and Associated run-off.*

In this paper, it has been shown that the rivers of West Bengal depend for their supply of water mainly on the rains of southwest monsoon season. The physical processes which are responsible for the production of this beneficial rainfall have been briefly described and the causes of heavy rainfall in North Bengal have been explained. The yield from the southwest monsoon in the catchments of different rivers of Bengal has been indicated. The problem of the different rivers of Bengal with reference to rainfall and run-off have been enumerated. It has been examined whether the rainfall in the catchment basins of the rivers are sufficient for agricultural purposes, for building up the delta and for pushing down the salinity which is trying to extend higher and higher. It has been shown that floods in North Bengal are often caused by local rainfall far exceeding the normal precipitation and not, as it is believed, by water from adjoining mountain catchments. Consequently, construction of retarding basin at a suitable place at the foot of mountains in North Bengal or conservancy of the river catchments in the mountains will not always prevent floods in the North Bengal districts though such retarding basins will have the effect of minimising to some extent the severity of the flood when there is simultaneous rainfall both in the mountains and in the Sub-mountain districts. Nature has made a present of large volume of water to us in North Bengal which, if husbanded by art, could suffice for the agriculture and industrialisation of a large part of the country. It has therefore been suggested that the feasibility for devising ways and means for economical storages and expenditure of this large volume of water by construction of reservoirs may be considered by engineers.

The review made shows that the rainfall in the different catchments of West Bengal rivers is sufficient to meet the needs of agriculture and to meet other requirements. The dwindling of the stream flow in the dry season is due to rapid expenditure of rainfall and consequent shortage in the storing of underground water which supplies the stream flow in non-monsoon months. With proper afforestation of the catchment areas it should be possible to retard the rapid run-off and to make conditions favourable for a storage of sufficient quantity of underground water. The construction of reservoirs, as in Damodar or Mor catchment, is a step in the right direction as this will overcome the difficulties in agriculture due to erratic nature of distribution of rainfall in certain years and will help to supply during the dry season, the water from the reservoir storage to maintain the necessary stream flow in the lower reaches of the rivers.

The problem in the rivers of Central Bengal have arisen not due to insufficiency of rainfall there but due to Bhagirathi river being cut off from its present source. Whether the position can be improved by the construction of a barrage connecting the Ganges with the Bhagirathi or whether the surplus water from the northern parts can be made available to meet the deficiency is a problem which the engineers will have to solve.

As regards floods, it has been stated that much could be done by the issue of timely warnings for mitigating the evils caused by floods. The prediction of floods or operation of reservoirs, if such reservoirs are constructed, can be attempted jointly by the meteorologists and hydrologists on the basis of (*a*) the weather chart, (*b*) the records of rainfall in the river basins and (*c*) the actual rise of streams in upper reaches.

7. SRI P. R. AHUJA and A. D. KHANNA : *Collection of Hydrological data of North Bengal Rivers.*

The necessity of collection of correct and comprehensive hydrological data for the preparation of reports on hydrology or river basins in connection with the planning of development and flood control projects, has been explained. The data required for this purpose has been mentioned and the method of presenting the same has been briefly described.

The list of hydrological data available for the rivers in North Bengal along with a map showing the gauge and discharge sites has been given. Some proposals for the establishment of additional gauge and discharge stations have been made.

A brief description of the major floods of the past and the disasters caused thereby has been given. The flood control projects under construction and proposed have been mentioned and they are shown on a map.

The efforts so far made and the work being done by the C.W.P.C. and the State Governments in connection with the collection of data have been stated.

8. SRI K. N. RAO (Poona) : *Hydro-Meteorological Studies of the Damodar and Mayurakshi Catchments.*

In recent years a number of hydrometeorological studies of Indian rivers have been made. The main results of study of the Damodar (1953) and Mayurakshi (1954) catchments are given in the present paper. About 80% of the annual rainfall of these catchments is received in the four monsoon months June to September; October accounts for about 6% only of the annual. The average rainfall of the two catchments is nearly the same (51″-52″ in a year) though there are differences in the distribution of heavy rainfall. The variability of monsoon rainfall is 16% for the Damodar and 19% for the Mayurakshi. The nature of the frequency distribution of seasonal rainfall is normal. There is no trend in seasonal rainfall during the last 60 years. The highest and lowest seasonal rainfall has not exceeded 1½ times and not fallen to less than two-third of the normal. Semi-logarithmetic curves have been fitted to the frequency distributions of rainfall of one to seven days. The maximum probable rainfall in one to five days has been indicated. All occasions of heavy rainfall have been examined. The tracks of the storms on occasions of very heavy rainfall lay mostly outside the catchment. Data of discharges of the Damodar river have been correlated with rainfall and regression formulae derived. A comparative study of the two catchments is included.

9. SRI G. N. DUTT : *Geological Aspects of North Bengal Floods.*

Recent floods in North Bengal in 1948, 1950 and 1954 have caused many casualties and considerable damages to private and public property assessed at many crores of rupees. On account of breaches on highways and railways, the traffic to North Bengal and Assam was interrupted for many months at a stretch.

As a result of the loss of lives and damage to property, the Government set up organisations both in the States and in the Centre, and the author was deputed to accompany three expeditions sponsored by the North Bengal Flood Enquiry Committee to study the catchments of the Tista and the Rangit in Sikkim State, and some of the smaller tributaries of the Tista, such as the Lish, Gish, Relli, Chel and Neora rivers in the Darjeeling district.

The main causes of floods, according to the reconnaissance surveys, were (1) abnormal and concentrated rainfall in the catchment areas; (2) widespread de-forestation leading to unchecked run-off of the major part of the precipitation; (3) the geological peculiarity of the water-shed and (4) the bursting of a glacial lake at the head of the Tista in one instance.

Consequent to the run-off over barren hill slopes, huge landslides occurred and soil-erosion took place and the debris caused an abnormal rise in the bed-level of the rivers downstream thus reducing their storage capacity. Soil erosion was also caused by over-grazing, forest fires, unscientific cultivation on hill slopes, and shifting cultivation.

Preliminary information about the behaviour of the Jaldhaka, Diana, Alaikuri, Torsa, Raidak and Sankosh rivers originating in Bhutan indicates that floods in these rivers were also caused by reasons similar to those in Sikkim and Darjeeling, but have been less calamitous because of restricted human interference. Bhutan has a density of population computed at about 16 per square mile compared with Sikkim's 50 and Darjeeling's 371.

The author discusses the physical features of Bhutan, Sikkim and Darjeeling, the geological aspects of the water-sheds and the causes of floods in North Bengal and suggests the remedial measures.

10. SRI V. S. RAO (West Bengal) : *Soil Erosion and Silt Problems and the Role of Forestry in Soil Conservation.*

Soil is the basis of plant and animal life, and therefore of human existence and civilisation. Plans that do not take this fact into consideration will have little meaning. The position with regard to soil erosion and floods in our country now is such that if we appraised it correctly we should have declared a national emergency and put soil conservation work on a war footing. Conditions for agriculture in India are not generally very favourable except along the river valleys. Even there however the floods have of late started creating havoc and despoiling large tracts.

The cause of the floods is to be sought for in the status of forests in mountain terrain. The position in the Himalayas is appalling and the costliest engineering works may fail to give permanent relief. There is a great need for observing the sanctity of forests, and a titanic effort would be necessary to restore forest cover over the large denuded tracts not only of India but also of Nepal, Sikkim and Bhutan.

Internally we have to stave off political meddling in forestry administration so that the interests of the future generations may not be sacrificed to the convenience of the indolent present.

Inordinate increase in population is the main cause of forest destruction. Limiting the number of our species to the optimum, and proper land use can alone save us from the certain calamity which is facing us.

11. SRI A. C. GUPTA : *Soil Erosion, and Silt Problems and the Role of Forestry and Soil Conservation.*

When a land starts developing fast from a primitive stage a planned development is necessary for its well-being, and this is particularly true of a hill area made up mostly of semi-crushed rocks and subject to very heavy rainfall. Such has been the case with the North Bengal hills and Sikkim where lie the catchments of many rivers. Nature had provided these areas with a great deal of rich forest which held the balance between the soil, the rivers and the elements, but with the start of development and advent of prosperity the population grew manifold, and before a realisation had dawned on the administrators practically all forests in the areas more favourably situated got depleted, and the delicate soil was subjected to all forms of malpractices. The inevitable followed in course of years, and heavy soil erosion, the silting up of water courses and floods resulted. Now therefore arises a question of remedy, but remedy is difficult in the altered circumstances of human needs. Special slip forestry which is the only known effective means of restoration of soil equilibrium has perforce to be practised, but in order to keep the problem of eviction and rehabilitation of peasants to the minimum only such areas should be treated under forestry as have completely gone out of hand, the rest being brought under conditional cultivation. The putting up of check dams in the waterways aimed at reducing the velocity of the flow is not considered wise until after sometime when the excessive soil erosion will have been brought under control, and thus the risk of the dams being completely buried removed.

12. Sri V. S. RAO (W. Bengal) : *Report on the Reconnaissance Survey in the Upper Valley of the Teesta River.*

This is a report by the author on the basis of observation reports by a team of four experts who visited the upper Valley of the Teesta in 1954.

The first part of the Report deals with a description of the region and the climate.

The questions referred to in the Report are :

(*a*) What are the causes of the floods of 1948, 1950, 1952 and 1954, apart from just heavy and concentrated precipitation?

(*b*) Are the floods due to progressive deterioration of conditions in the catchment which can be stopped or arrested? Do such conditions still exist and are they likely to give rise to disastrous floods in the future as well?

(*c*) Are these matters of the nature of unpreventable happenings of great magnitude beyond the power of human control and remedial measures? If not what can human endeavour do to mitigate disaster and finally to eliminate it altogether?

After detailing the observations made regarding the Laching, Lachen and Dikchu valleys, the Report discusses the cause of the floods and points out that several factors contributed to it. Excessive concentrated rainfall is one. Rock and soil slips are another. The bed of the Teesta below the railway bridge at Sevoke has been raised dangerously high by deposition of enormous quantities of eroded material. But the landslips and soil erosion are themselves the effect of (*a*) unwise removal of forest cover on steep hill slopes, (*b*) practice of shifting cultivation, (*c*) extensive cultivation of hillsides and (*d*) open grazing of large herds of cattle. The Report is definite that landslips were not caused by any major geological upheavals. These causes operating for over a century has reached a critical point and started making themselves felt since 1948. The Report then discusses remedial measures which include several checkdams at the following sites.

(*i*) A dam of about 200 feet near Makah suspension bridge.

(*ii*) One on Teesta river about 300 yards upstream of the confluence of Talung Shhu.

(*iii*) A dam of about 200 ft. height and 1,500 ft length about 800 ft. up-stream of the Tong Suspension Bridge on the Teesta.

(*iv*) One on Lachen River—existing natural dam may be strengthened, above the confluence with Film Chhu.

(*v*) One on Demu River near its confluence with Lachen.

(*vi*) One on Laching River at Mile 38¾—150 ft. height.

Discussing the long-term measures, the Report strongly emphasizes the need to restore the health of the catchment by means of a dense, many-tiered permanent vegetation. For this purpose some concrete policies are suggested.

13. Dr. N. K. BOSE, Director; H. R. PRAMANIK and G. SINHA (W. Bengal) · *Flood Problems of North Bengal Rivers and how to solve them by Model Experiments.*

The Sub-Himalayan rivers in North Bengal present certain problems which admit of no easy general solution. Due to flashy conditions the flood levels build up very quickly without any prior warning thus inundating vast tracts of agricultural and habitable lands. These flood waters bring in huge quantities of coarse silt which settle on the agricultural lands and spoil productivity. Loss of life and property in towns and villages are equally crippling. Due to steep bed slope the velocity in the rivers at high stages is very high which causes extensive bank erosion and consequent damage to the properties situated on the banks. Of the five North Bengal districts the worst affected by these floods are :—Jalpaiguri and Coochbehar. Of late, these floods have been of quite frequent occurence having taken place in 1950, 1952 and 1954. The increase of the floods in recent times may be partly attributed to a systematic deforestation in the hills which are drained by these rivers. The 1954 flood was of very high intensity when almost all the North Bengal rivers (viz. Mahananda, Kaljani, Teesta, Jaldhaka, Karala, Leech, Gheesh, Chel) were in spate, and it became important to find a remedy to this problem which was causing great suffering to a large number of people in North Bengal.

To find a permanent solution of this problem it would be necessary to take detailed hydrological observations on these rivers and draw up an integrated plan to this end. Systematic afforestation to prevent soil erosion in the upper reaches of the rivers is one of the possible solutions. This would reduce silt charge in the rivers and stop the raising of river beds which is one of the major causes of these floods. It may be necessary to build a series of flood-retention reservoirs on the major rivers. But if this is not accompanied by afforestation in the upper reaches, the huge quantity of silt carried by these rivers would cut short the livers of these reservoirs to a great extent. Before such an integrated plan could be drawn up and implemented, it was considered necessary to give local protections to certain towns for immediate relief of the affected people. It was necessary to study in scale models the effectiveness of the measures proposed to this end. The River Research Institute, West Bengal, has studied some of these problems of protection of the towns, i.e., of Siliguri and Alipurduars, in scale models. The problems of these two towns in brief, are :—

(1) *Siliguri town protection* :—The town of Siliguri is situated on the left bank of river Mahananda. On the opposite bank (which is the silting bank) the railway authorities have constructed railway sidings by gradual encroachment on the char land. As a result of this, the river cannot cut through the char even at high stages, and is forced to flow hugging the left bank. During the 1954 flood severe erosion and inundation of about 5 square miles of land took place on the left bank near the town of Siliguri. The problem was to save the area from erosion which may ultimately result in the outflanking of the rail and road bridges connecting Siliguri and Darjeeling. In the scale model the protective works suggested by the Irrigation authorities were tested and a solution was also evolved.

(2) *Alipurduars town protection* :—The town of Alipurduars is situated on the left bank of a big loop of the river Kaljani. This town was heavily flooded during the high flood of 1954. The remedial measures suggested by the Superintending Engineer in charge were :—(1) Constructing flood embankments, (2) Effecting a straight cut through the loop which would divert the river away from the town. The proposal (2) was tried in the scale model and found unsuitable as this cut, if it develops at all, would adversely affect the railway bridge situated above the loop.

The study in models of the problem of protection of other towns in North Bengal from flood havocs is being taken up one after another in the River Research Institute.

14. SRI E. A. R. BANERJI (W. Bengal) : *Problem of Flood Control in Keleghai Valley.*

Keleghai is a river which has its origin in Dudkundi, Jhargram P.S. (Midnapore District of West Bengal). This river passes through or along with the boundaries of Keseari, Kharagpur, Narayangar, Potashpur, Sabang, Bhagabanpur, Moina, etc. before it falls into the Haldi river. The valley of Keleghai river in its upper catchment is moderately undulating and below Keseari becomes fairly flat. The river in its course is also fed by a number of tributaries from the North as well as from the South. During the dry season of the year there is little water in this river, but during monsoon the uncontrolled run off from the extensive bare catchment area swells the river unduly and creates floods in the lower valley. The principal reason for this is the almost complete deforestation of upper catchment and heavy grazing which is still practised, hardly allows any vegetable cover to regenerate and check the run off.

Efforts have been made in the past to tackle the flood control in the lower valley from several angles, viz. by widening, and deepening the river, strengthening the embankment, digging diversion cuts etc., but none of them proved effective. The possibility of flood moderation by reservoir in the upper catchment was also considered but due to absence of suitable site for a dam of even moderate dimension this was ruled out. Besides, even if the dam is constructed it will not solve the problem permanently. Such structures under the existing condition will have a very short life.

In view of the above position an attempt is being made to tackle the problem from soil conservation point of view. Under this manner of approach it is contemplated to put a forest belt in the topmost contour of the upper catchment and to contour bund the area below the forest. By the above operation it is expected that the run off from the upper catchment would be considerably reduced and eventually it may control the floods in the lower valley which is at present causing great distress to the people of the locality. Under the above programme of work it is also intended to utilise the land of the upper catchment more profitably for producing food both for man and cattle. The details regarding the manner in which the work will be carried out and its likely effect on flood moderation have been discussed in the original paper.

15. SRI R. B. CHAKRAVARTY (W. Bengal) : *Possibilities of Irrigation in West Bengal.*

For various reasons growing of more food has become essential in West Bengal after partition of the Province. Extent of culturable land being limited the only possible way for growing more food is to increase the yield. This may be done by use of scientific methods of cultivation and manuring. Simple manuring is not beneficial to crops as it must be presented to the plant root in a solution more diluted than the strength of the solution inside a plant, otherwise instead of plant food going inside a plant fluid from inside the plant would come out. Hence with the increase in manuring there must be an increase in supply of water in the root zone which is possible only by irrigation. From the point of view of irrigation West Bengal may be divided into 4 zones, Western, Southern, Northern and Central zones. The Western zone is most suited to irrigation and already a substantial part is under irrigation. The Mayurakshi canals and Damodar canals (with Eden canals) already irrigate a substantial part of this area. With the completion of the Durgapur canals and the Kangsabati canals the area brought under irrigation will form a major part of this zone. There are a number of comparatively smaller irrigation schemes in this area. There is also possibility of a few more irrigation schemes which, of course, will be as big as the three mentioned above.

In the Southern zone not much irrigation is needed but cultivation may be made and yield increased if drainage is attended to. Some amount of irrigation is also necessary in the upper part of this area for raising a second staple crop. The Sundarbans area has a great potential for land reclamation and it is suggested that complete reclamation of this land may be kept in abayance for future generation who may have to face a more serious problem in the matter of food. However, the planning should be started ahead so that the prospects are not ruined beforehand. The Northern zone requires little irrigation as the rainfall is fairly heavy. But as in most other areas in the monsoon belt irrigation is necessary for raising a second crop. The Central zone was once a very flourishing area but owing to rivers becoming decadent fertility of the land has become poor. This may be improved by flushing occasionally with fresh water so that the accumulation of silt is washed away. Apart from this, this area also requires irrigation for growing Rabi crops including sugarcane. A dose of water during the flowering season of Aman rice (October) is also beneficial even in this area.

16. SRI S. GUPTA (W. Bengal) : *Problems and possibilities of Irrigation.*

Irrigation in West Bengal almost entirely connotes the irrigation of rice, the staple crop, which sustains the population.

The broad-cast varieties or true Aus, maturing in August or the Boro paddy grown in winter under irrigation, have been rarely in evidence in the irrigated areas. It is a paradox that though this rice is grown during the season of maximum rainfall, it still needs irrigation. The reason is that the rainfall itself is variable both in quantity and in distribution.

The object of irrigation is to ensure supplies of water as and when required for the agricultural processes so that not only the crops are protected but also to augment the yield that irrigation, particularly from silt-laden river supplies can ensure.

Given proper distribution, a total supply of about 25" may be sufficient for raising a successful harvest. The optimum requirement would be of the order of 40". In any case quantity and distribution must both be ensured. This will go to show the necessity for ensuring supplementary irrigation.

The rivers in the area have a very variable discharge. The river discharge at the headworks and the likely natural flow below the storage dam are assessed and water admitted into the head canals. If further supplementation is required, a call upon storage is made. Due note has to be taken of lags in discharge and time in deciding upon the requirements. The requirement is very variable—from full discharge to nothing or almost nothing.

In the initial stages outlets have to be fitted in by trial. The problems of first irrigation are that while there may be too strong a flow at an outlet, that at another may be meagre. There may be too much water at one place and too little or none at another. There may be water-logging at one place and quick drainage elsewhere. According to the local conditions and in conjunction with the cultivators the inequalities of flow are evened out by controlling and guiding the flow. Irrigation is field to field. Control and distribution are greatly assisted by their being divided into plots with the surrounding boundary ail bunds (ridges).

The irrigation requirement of water may go upto 12" in a season—3" during the ploughing and preparatory stages, 6" during transplantation and 3" during maturing. In years of good rainfall it would be less and may even come down to 3". Irrigation also helps in reducing the time required for the plants to take root and turn green again after the post-transplantation paleness.

Another effect appears to be that the greater moisture in the soil tends to retard flowering, maturing and the drying of the plant and consequently harvesting. The time fixity of Aman paddy is subjected to a degree of flexibility. Harvesting thus tends to be pushed further into December.

A few other effects noticed are :—

(*i*) Irrigated paddy tends to have less tillering and a smaller number of grains per ear than unirrigated paddy. But the weight of the grain is greater. It would appear to mean more mature grains with perhaps a greater protein content and a lighter husk. The proportion of chaff would be less. It would seem that it would stand milling better too with less beakage.

(*ii*) Significant increase in yield appears to come about from at least three waterings—one each during transplantation, growth and maturing.

The additional yield expected may go upto 14 maunds per acre, the average immediately standing at about 6 maunds per acre. Later on the average increase may go upto about 9 maunds per acre upon greater standardisation. The requirement, however, both from economic and agricultural reasons, is that it is necessary to introduce double-cropping in the single-crop Aman areas. Or alternatively it is necessary to have a value cash crop, such as Sugarcane. For this the demand will create the supply.

17. SRI E. A. R. BANERJI (West Bengal) : *Problems and Possibilities of Irrigation Agriculture in West Bengal.*

Although the State of West Bengal has a rainfall which varies from about 50″ to 150″ we are soon going to have large areas under irrigation. This appears to be paradoxical, but nevertheless it has been felt necessary due to the fact that most of the precipitation is received during a specified period of the year and the rest of the year remains dry. In order to maintain the heavy population pressure irrigated agriculture is absolutely necessary for West Bengal and as such, we have launched the various irrigation projects in the State and given great importance to irrigation for raising the agricultural standard of our country. If, however, we examine the history of irrigation agriculture from the dawn of civilisation we will find that if irrigation agriculture is practised without proper precaution there is considerable danger of many complications arising in the future.

So far West Bengal is concerned, the principal danger arising out of irrigated agriculture is the rise in the water table and creation of more swampy areas in the State.

One of the fundamental principles of going in for irrigated agriculture is also to provide adequate drainage condition, so that the water that is poured over the land artificially can also get out quickly and not bring about waterlogging. Under waterlogged conditions excepting rice and certain aquatic crops no other crop can be grown and the land deteriorates in its productive capacity.

In many parts of West Bengal the conditions which are likely to arise due to irrigation practices have already arisen due to the effect of heavy rainfall in these areas, and as a result to-day the major portion of our cultivated area is only suitable for Aman rice production which has limited the cropping capacity of our lands. If self-sufficiency is our aim, we have to adopt multiple cropping and in order to do so it is necessary to carefully study the question of drainage along with irrigation. Just as irrigation is necessary to increase the production unless proper drainage conditions are also created in the State it will be difficult to realise the dream.

18. DR. S. K. MUKHERJI (W. Bengal) : *Effect of Irrigation upon the soils of the Damodar Canal Commanded Areas of Burdwan.*

The paper indicates the comparative advantages and disadvantages of irrigation by canals and tubewells in the commanded area. The different kinds of soils in the commanded area are laterite, Red Soils, Damodar Uplands, Damodar Flat lands, Damodar Riverine lands, Ganga Flat lands, Ganga Riverine, Damodar Flat lands over buried laterite. The paper then goes on to indicate the most probable reaction of these different soil groups under irrigation.

Laterites : Not included in the commanded area. An analysis of the soil is first given. There is hazard of scouring of surface soil by the velocity of flood irrigation by a single puncture in the canal for a large area.

Damodar Uplands : Problem of scouring of soil by velocity of water. Therefore there is need to design canal irrigation as to ensure slow movement of water. Chances of water logging remote so long as the numerous minor rivulets which drain the subsoil are not plugged.

Damodar Flat lands : The area has a good subsoil drainage.

Damodar Riverine Land : The seepage and saline subsoil are the two disadvantages of this soil series. The numerous rivulets are usually blocked to obtain irrigation water and this has caused the raising of their beds. The remedy may lie in bunding of rivulets and re-excavation of the beds wherever necessary, prohibition of cultivation in the beds and creation of new arteries to carry off excess subsoil water.

Ganga Flat Lands : Much of this area is waterlogged and cultivation is limited to the peripheri. Rise in the watertable will submerge valuable paddy areas.

Ganga Riverine : Bhagirathi and its tributaries help in underground drainage. Cultivation of river beds to be avoided.

19. SRI D. MOOKERJEA : *Necessity of a Centralised Water Control Planning Organisation in West Bengal.*

In order to get maximum advantage of our Water wealth we must have complete knowledge of our water resources—its availability, utility and proper and efficient disposals. Hydrological and meteorological data need also to be collected in a thorough manner. Only schemes based on reliable data can get preference for their acceptance by the Centre in the race between states in the submission of such schemes.

At present collection of data is under the charge of regular territorial divisional officers who find little time to concentrate on this job. Then there are other special difficulties facing West Bengal such as tidal effects on rivers, catchment areas lying outside the state boundaries, etc.

It is suggested that a separate central organisation for the state be established for the collection of hydro-meteorological data throughout the state. This organisation should also be entrusted with the task of increasing the yield of all agricultural produce by optimum use of water for each variety of crop.

20. SRI A. K. BHAUMIK (West Bengal) : *Power Development in West Bengal.*

The paper surveys the rapid development of power in India from 14 units per capita in 1950-51 to 25 in 1955-56 rising to 50 at the end of the Second Five Year Plan. It then deals with Hydro Generation in West Bengal in the first Plan period and describes the schemes of Jaldhaka and Balasun undertaken for completion in the Second Plan period. Thus in 1960 the hydro-electric generating capacity will be 36 MW in the State.

Possibilities of development of hydropower from Teesta to the extent of 300-400 MW are indicated.

The paper then goes on to discuss the necessity and resulting economies effected from the establishment of a High Voltage Grid from North to South.

Dealing with the thermal power, the paper discusses the need for augmenting the capacity of the plant at Durgapur to 180 MW.

Finally the paper discusses the inevitable necessity of establishing an Atomic Power Station of capacity 100 MW or more in West Bengal which is one of the largest industrial regions in the country and where the rate of demand for power is outstripping all expectations. The technical problems arising out of such an Atomic Power Station are then briefly mentioned.

21. Dr. A. LAHIRI : *Coal Resources Development of the Damodar Valley Coalfields of West Bengal.*

Coal constitutes one of the chief mineral resources available in fair abundance in the Damodar Valley area of West Bengal. The paper presents a general outline of industrial development of the area where coal of all categories viz. coking, semicaking and non-caking, can make a substantial contribution for initiating growth of industries (including electric power) based on coal and its by-products.

22. Dr. M. DATTA : *Water Power Resources of West Bengal.*

Hydro-electric installed capacity in West Bengal is only 6760 kW of the total aggregate installed capacity of 552,329 kW in the State. The two major reasons for this negligible harnessing of hydel power in the State are (1) comparatively high cost of developing water-power sites and (2) proximity of coalfield to industrial regions of the State.

The rivers in West Bengal can be categorised in three groups :

Group I. The river Hooghly flowing through an area absolutely flat holds out no prospect of hydel generation except perhaps in her deltaic region by utilising its tidal flow which is also a remote possibility in view of the very little progress made in this direction.

Group II. The Subarnarekha, the Cossye, the Damodar, the Ajay, the Mayurakshi flowing mostly from West to East hold prospect of harnessing for irrigation, flood control and power generation, the headworks for which, in general, have to be constructed in their upper mountainous courses mostly outside the jurisdiction of the State. Of these multi-purpose projects, the Mayurakshi Project has been fully implemented, Damodar Valley Project is under implementation, and Kangsabati Reservoir Project has been included in the Second Five Year Plan for irrigation and flood control—power generation being deferred to Third Five Year Plan.

Group III. North Bengal rivers have tremendous hydel power potential. Because of the seasonal variation of the flow the scheme for generation of power will, in certain cases, be based on run-of-the river and in certain other cases, on the run-off supplemented by a storage reservoir.

Jaldhaka Hydro Electric Scheme now under implementation under the Second Five Year Plan in this region envisages to generate 12,000 kW of firm power and another 12,000 kW of seasonal power. The river Jaldhaka is envisaged to be harnessed in seven successive stages commensurate with the growth of load yielding in aggregate about 93,300 kW of power on completion of all the stages.

Balasun Hydro-Electric Scheme envisaging to generate 2000 kW of firm power and 2000 kW additional firm power prepared for inclusion in the Second Five Year Plan has been deferred for paucity of funds. Two other rivers viz. Jainti and its inflow Katulum whose power potential has been assessed of late can have a capacity of 11,000 kW. Another big river, the Raidhak holds out the potential of generating about 75,000 kW of power.

23. Sri A. C. GUPTA : *The Sundarbans, its Problems and its Possibilities.*

The large tidal delta in West Bengal known as the Sundarbans was formed ages ago in the floodplane of two large rivers, the Ganges and the Brahmaputra, emanating from the Himalayas and more or less converging in the area formerly occupied by undivided Bengal. In the 14th century A.D. the main flow of the Ganges having diverted to the Padma from the Bhagirathi the waterways in the western part of the Sundarbans, the whole of which now lies in West Bengal, started silting up as a result of the back rush of silt from the continental shelf in the bay into the rivers with the flow tide, and the Sundarbans thus gradually turned into a problem area. Except for a limited amount of cultivation on its borders, especially the west and the north, the entire area was wooded with mangrove species, and was an uninhabited waste until the middle of the 19th century when the British Indian Government induced the surrounding population to reclaim areas by granting many concessions. Very large areas were leased out to land speculators, who under the terms of the lease cleared the land of forest and put marginal embankments to check the ingress of the tide water, which was highly saline. The lessees not however being bound to maintain the embankments in a good state of repair the tenants suffered very heavily whenever there was a breach, and breaches were not infrequent. The system not having thus proved a success it was discontinued in 1905 and no further large grants were made to land speculators. Instead, small leases were granted to cultivators and the State took upon itself the burden of putting up embankments and maintaining these. Even the State management has not been an unqualified success for breaches often occur in the embankment and large areas of cultivation are inundated with salt water. The trouble and expense of relief, rehabilitation, resealing and resweetening prove considerable. Besides, the beds of the waterways are steadily rising particularly for the reason that the areas of normal spill have been to a great extent shut out by the erection of embankments. The result of this has been to expose the reclaimed areas to an increasing degree of risk of inundation with salt water. The remedy suggested include

(1) The resumption by State of low-lying reclaimed areas by batches, removing the embankment and leaving the areas to nature for a certain number of years so that a vertical growth of land may take place;

(2) Reconstruction of embankments leaving a marginal strip of land between itself and the river, and the afforestation of the strip;

(3) Provision of shelter belts of suitable trees within the enclosed areas to keep out saline sprays;

(4) The control and regulation of siltation in the rivers and the spillways.

It is confidently expected that if salt in all forms can be completely kept out of the reclaimed areas the productivity of the land will greatly increase, and besides, certain essential crops such as jute, which cannot be grown now, will be possible to cultivate.

24. SRI KUMUD BHUSHAN RAY : *Flourishing Sundarbans.*

The formation of the Sundarbans Delta is connected with the changes in the river systems in Tibet and North India. In pre-vedic times, the Tsangpo water flowed west through the Indus. In vedic times, it flowed through the Saraswati. About 5,000 years ago, it started flowing through the Gora-Gandak-Ganga, when delta formation in the Sundarbans was accelerated. Between the 6th and 12th Centuries A.D., Tsangpo water flowed east, through the Brahmaputra in Assam. This finally led to the diversion of Ganga water through the Padma into the Meghna. Delta formation at the mouths of the Bhagirathi thus decreased; while at the mouths of the Meghna, it increased.

The crumbling of the 'young' Himalayas, and transportation of the debris as silt load and its deposit on the sea bed, formed the deltas. In this process, there is decrease in the load on the earth's crust in the uplands and an increase in the load on the earth's crust in the deltas. Under the principle of 'isostasy', there is a slow movement of elevation of the mountains, together with a slow movement of depression in the deltas. The submergence of deltaic regions in the Sundarbans, Holland and other countries, is the result of isostasy.

The Dutch have reclaimed 2000 sq. miles of deltas in southwest Holland, but the health and prosperity of their country have not deteriorated, while rivers have remained in good condition. The reclamation of the Sundarbans Delta will not also cause deterioration of health and prosperity of the country or of the rivers, like that of 2000 sq. miles of deltas in Southwest Holland.

Reclamation work in the Sundarbans is retarded due to the high cost of breach repairs in the bunds by the Irrigation Engineers, who employ the orthodox methods of ring bunds, sal bullah and bamboo piles, dumping of earth filled gunny bags, etc., and brick filled wire-netting sausages, and even sinking of a number of loaded boats. The cost of the Kulgachi Breach repairs, in the Haroa Gaug, in 1953-1955, was over Rs. 7 lakhs.

By adopting the method of 'permeable screens', a river can be assisted in the utilisation of the mighty force of its current of water, thereby creating a new river bund by the deposit of silt, to close a breach in the bund, the cost of which is less than 1/7th of that by the orthodox method.

Thus instead of having to spend Rs. 1 crore annually for repairs to breaches in bunds, etc., only about Rs. 14 lakhs will be necessary, which can be met from the annual revenue of Rs. 25 lakhs from the Sundarbans in West Bengal.

'Permeable screens' can also be used to narrow, deepen, canalise and stabilise the wide and shallow channels. The lower tide level in a deepened channel, ensures reclamation of a larger area. Moreover, where no bunds have been constructed as yet, such lands can also be cheaply and effectively reclaimed by 'permeable screens'.

The whole of the Sundarbans Delta in West Bengal could thus be restored to a flourishing condition of the 12th-17th centuries.

25. DR. N. K. BOSE, Director, P. B. ROY & G. SINHA, W. Bengal : *Tidal Rivers of Bengal and the Problem of their Maintenance.*

An enormous quantity of silt is brought down every year by the Ganga Brahmaputra river system during flood and when these come in contact with the saline tidal waters from the Bay of Bengal the silt in suspension is deposited at the seaface with gradual formation of land. This is in short the history of the Gangetic delta. This deposited silt remains mostly in an unconsolidated state and a part of it is picked up during the flow tides twice daily throughout the year and is carried inland in suspension through tidal rivers and creeks. So long as the country side on both banks of these tidal channels is low, the silt laden water spills over both the banks and silt is deposited on low areas raising the level of land. The silt from water as it goes back through the creek to the sea keep the rivers alive. But if the lands are reclaimed prematurely for settlement (when the levels are still below high water level) embankments are put on both banks to check saline tidal inflow, all spills are closed and the silt brought in flow tides are deposited in the river. If at the same time the river does not get any perennial upland discharge the silt carried up by tidal flow remains on the river bed itself and the river bed begins to rise. Once the deterioration starts the river becomes inactive within a very short time. The only way to revive and maintain a decaying tidal channel is to supply upland discharge for flushing or to throw low lands open for free spilling if upland supply cannot be obtained. It is however very necessary to find out the requisite quantity of upland discharge or the extent, location and spacing of spill areas so that the whole reach of the river may be maintained in regime condition.

Now introduction of any change in a tidal river for improvement will have its effect on the entire river system and in order to find out satisfactory remedial measures, the whole system should be carefully studied before and after the proposed modification. To carry out such studies in a tidal river system no cut and dried methods are available. The problem can be examined in a scale model or by mathematical computations,

PART I—TIDAL MODEL

The hydraulics of tidal river being complicated the operation of tidal models is more difficult than that of non-tidal models. However, though there are limitations it is possible to use scale models for the solution of problems of tidal rivers, and tidal models have been successfully used at different places. When the problem of navigation is involved tidal models are usually made of movable bed but when the question is of drainage and maintenance of the river in regime condition the model can be made rigid, and rigid bed models have been successfully operated in West Bengal for solving their problems. In this case, the velocity of the river is the guiding factor for the study and an accurate knowledge of flow and ebb velocities at different phase of the tidal cycle, before and after any modification is essential. It is the experience of Bengal Engineers that an ebb velocity greater than 3 ft./sec can scour and maintain the river in regime condition. Hence while conducting experiments attempts are made to increase the ebb velocity above this limit and that also for a sufficient duration of time. The specific case model experiment on Tolly's Nullah a tidal creek of the river Hooghly has been described in this paper.

PART II—TIDAL COMPUTATION

The limitations of the tidal models make their operation more difficult than the models of one way rivers. A direct mathematical approach is therefore desirable to check up result for tidal models. But the mathematics of tidal motion is so complicated that no simple and easy method can be laid down for solving the equation.

Attempts have, however, been made specially in the Netherlands where the tidal rivers play a great part in the national economy to use simplified schematisation of tidal rivers, so that a solution of the equations of motion and their application to solve the problems of these rivers might be possible. Since no direct and exact solution of the equation of tidal motion can be derived, attempts have been made by different authors to introduce different simplifications and to make a mathematical approach to the problems in different ways. In some cases straight forward computations are resorted to but in most cases different techniques like successive approximation, series expansion, trial and error method etc. have to be applied. On the whole the mathematical approach to the problem is sometimes very useful, provided it is applied judiciously. It goes without saying that it requires skilful and experienced computers to make efficient application of these techniques.

The technique of the execution of the computational method is somewhat similar to the operation of scale models. In the first place the state of motion (head velocity etc.) at different points of the river in the existing condition is first computed from some known data like the tidal curve at the seaface and the upland discharge at the upstream end. Comparison of these computed flow conditions with those observed in the existing river goes, so to say, to prove the mathematical model. Any change in the river in the shape of constructions for remedial measures, may now be considered and fresh computations done with the imposition of these alterations. This gives the effect of this alteration on the flow conditions in the river.

Since both hydraulic models as well as different methods of computation have got their limitations it is advisable to use both of them in the investigations on a proposed change in the River system and compare the result. In the Netherlands both these methods as well as the use of Electric Analysis model where possible play a great part in the solution of various problems relating to tidal rivers.

The relative merits of the two methods have been described in brief in the paper and the actual computations carried out for the Tolly's Nullah have also been discussed.

26. SRI SATYAKAM SEN, West Bengal : *Economic Aspects of Drainage in the Lower Reach of Damodar.*

Floods in the Lower Reach of Damodar take place during monsoon. Consideration of the present data and past record show that more than half the number of floods in the Damodar river do not carry a maximum discharge of more than 300,000 cusecs. Discharge of more than 450,000 cusecs occur but rarely, although peak discharge of about 600,000 to 650,000 cusecs has been recorded on several occasions during the 19th and the 20th centuries.

The lower reach of Damodar has been mainly an agricultural region, and agricultural practice, despite the destructive effect of the floods, has been much aided by them, by fresh deposition of silts. However, not only the shifting of the drainage lines of this river, but also disturbance of drainage by man have greatly affected the cropping plan of the area. The trans-Damodar tract which used previously to be inundated by flood water, is now a Rabi crop area. It possesses a low-lying topography; and therefore the question is one of drainage rather than of irrigation.

Drainage does not play an exclusive role in the location of Industries in the lower reach of Damodar; yet some industries like those of transport equipment, paper, etc. are extant by this river. Industries are also appearing to cluster round the Durgapur catchment area. One may apprehend loss of fertility in some regions below the catchment and prevalence of ill health of men and cattle due to injurious effluents from these industrial sources.

Considering the important industrial establishments and the mineral deposits which occur by the river, Damodar, navigability of this river is very important. In fact, much riverine traffic was afforded in the old days by the Kana Damodar, Kunti Nadi etc. until siltation of the river channels led to their deterioration. The navigability of the lower reach of Damodar was indeed adversely affected to a great extent in recent years, that is, until D.V.C. navigation canal came to offer relief. However, although maintenance of suitable draft for big barges to ply through, has been ordained with location of multiple locks, the very design has necessarily slowed down progress of traffic.

The settlement patterns in the lower reach of Damodar is closely linked with its drainage conditions. There are settlements in bee-hive, as well as linear patterns depending on whether drainage lines are absent or nearly so, or whether there are flood plains and embankments along the river, respectively. However, in some parts, settlements also occur as irregular agglomerations. Drainage lines have always mainly influenced human settlement patterns along the lower reach of Damodar.

These therefore provide a clear picture of the various aspects of the lower reach of Damodar, which affect the economic status of the area.

APPENDIX

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